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APRIL 2024

RESERVE BANK OF AUSTRALIA

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APRIL 2024

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Assessing Full Employment in Australia

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Photo: Orbon Alija – Getty Images

Abstract

Full employment is a longstanding objective of monetary policy in Australia, alongside price stability. The Reserve Bank Board aims to achieve the maximum level of employment consistent with low and stable inflation in the medium term. This article explains how RBA staff form an assessment of how labour market conditions stand relative to full employment. RBA staff draw on a range of labour market indicators, model-based estimates and outcomes for wages growth and inflation. Any single indicator tends to provide a partial view of the labour market and the level of each indicator that is consistent with full employment can change over time as the structure of the economy evolves. Ultimately, assessing how close the labour market is to full employment requires careful judgement, which the RBA sets out in its quarterly *Statement on Monetary Policy*.

Introduction

Monetary policy in Australia has traditionally aimed to maintain price stability and full employment. The price stability objective has, for some time, been defined in terms of the target range for consumer price inflation of 2–3 per cent. In contrast, the full employment objective does not have an equivalent numerical target. Following the 2023 Review of the RBA, the mandate for both objectives has been made more explicit in the updated *Statement on the Conduct of Monetary Policy* agreed between the Treasurer and the Reserve Bank Board, with the Board committing to regularly communicate 'its assessment of how conditions in the labour market stand relative to sustained full employment' (Treasurer and Reserve Bank Board 2023). An explanation about the role of full employment in monetary policy was provided in the February *Statement on Monetary Policy* (RBA 2024). This article explains in more detail how RBA staff form an assessment of labour market conditions relative to sustained full employment.

Full employment and monetary policy

What is full employment?

The Reserve Bank Board aims to achieve sustained full employment. This is the maximum level of employment that is consistent with low and stable inflation in the medium term; it can change over time as the structure of the economy evolves.[1]

At full employment, there is a balance between demand and supply in the labour market. This results in wages growth that is consistent with low and stable inflation in the medium term, taking into account the rate of productivity growth over time. Sustained full employment also coincides with balance in the markets for goods and services in the medium term, at which point firms' ability to raise prices is also consistent with achieving the inflation target. That said, price and wage-setting frictions and disruptions in the production of goods and services can lead inflation to deviate from the inflation target for a period even when the economy is at full employment.

If there is too little demand for labour – because of a lack of aggregate demand for goods and services – there will be additional people unemployed or underemployed, which can have a large financial and social toll. This 'spare capacity' in the labour market also puts downward pressure on wages growth and inflation. By contrast, if the demand for labour is well above the available supply – because aggregate demand is strong – fewer people will be unemployed or underemployed. Hence, businesses will offer higher wages as they struggle to fill vacancies and experience high staff turnover. Although higher wages growth and employment are features of a strong and productive economy, when aggregate demand is in excess of productive capacity, they can become unsustainable and place upward pressure on inflation. Persistently elevated wages growth that flows into higher inflation is a clear sign that the labour market is tighter than full employment.

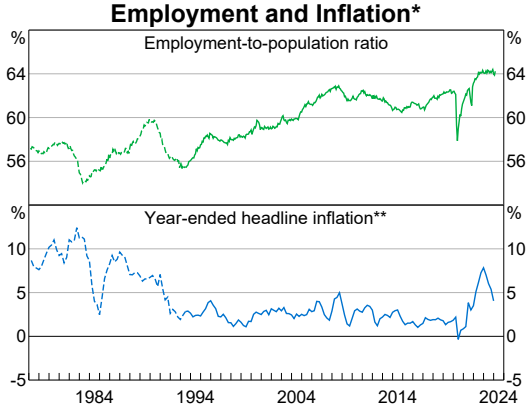
There are still people who are unemployed (i.e. they are looking for a job) or underemployed (i.e. in work, but wanting more hours) when the economy reaches full employment. This is, in large part, because of so-called 'search and matching' frictions, such as how easily jobseekers can find vacant positions and the extent of any skills or location mismatch between jobseekers and vacancies, which mean that people who are looking for jobs or additional hours may not find them immediately.[2]

Why is full employment a moving target?

We cannot directly observe the level of full employment, but we know it varies over time due to structural changes in the labour market. For example, over the past 30 years the employment-to-population ratio has steadily increased, while inflation has remained low and stable for most of that period (Graph 1). This suggests that the maximum number of people employed for a given population has increased over this period, alongside the increase in workforce participation. Our assessment of full employment needs to consider not only the number of people in employment relative to those who want to work, but also the number of hours that people currently work relative to the number they would like to work, which may also have changed over time. In general, labour demand must grow with the supply of labour to sustain full employment.

Graph 1

Employment and Inflation*



* Solid lines represent outcomes during the inflation targeting period.
** Excludes interest charges prior to the September quarter of 1998; adjusted for the tax changes of 1999–2000.
Sources: ABS; RBA.

The balance of labour demand and supply consistent with full employment depends on structural features of the markets for labour, goods and services. For example, search and matching frictions lower the level of full employment.[3] These structural features can change over time. Government policies can influence both structural

features of markets and labour supply decisions, and so influence the level of full employment.[4]

Monetary policy has little direct effect on labour supply or structural features of the job market, rather the focus of monetary policy is to minimise short- to medium-term economic cycles. But periods of unemployment can reduce workers' earnings for several years afterwards and long spells can lead to skills atrophy, or cause workers to leave the labour force altogether, eroding the level of full employment that can be sustained (Borland 2020). So by acting to reduce the severity and duration of economic downturns, monetary policy may also be able to limit the extent of these so-called 'hysteresis' or 'scarring effects' on workers who lose their jobs during these episodes.[5] And by helping to achieve low and stable inflation, monetary policy supports strong and sustained employment growth in the long run. This is because it creates favourable conditions for households and businesses to make sound decisions about how to spend, save and invest.

Assessing how close the labour market is to full employment

We draw on a broad suite of indicators to inform our overall assessment of labour market conditions. This includes labour market data, survey measures, information from liaison with businesses, model-based estimates, and wages growth and inflation outcomes. Our assessment also draws on economic research and the views of academics, market economists, government agencies, international organisations and other central banks. We also engage with key stakeholders that represent the interests of workers and groups that typically have greater difficulty finding employment.

The main focus of our assessment is fluctuations in the balance of demand and supply in the labour market (spare capacity or, conversely, tightness) over the short-to-medium term; that is, deviations of labour market conditions from full employment. By removing slow-moving structural trends from a range of labour market indicators, we can isolate this short- to medium-term cycle. Models are particularly useful in extracting this cyclical signal in a systematic manner.

A key issue for assessing spare capacity in the labour market is determining how it relates to inflationary pressures. Structural changes in the markets for labour, goods and services can all affect the extent of inflationary pressure that a given set of labour market conditions generates. For example, a key component of price inflation is growth in unit labour costs, which are driven by both wages and productivity growth. A persistent change in productivity growth would mean that the rate of wages growth required for inflation to be sustainably in the target range must also change. As such, an assessment of the maximum level of employment that can be sustained with low and stable inflation is best done in the context of a broad view of economic developments.

Careful judgement is needed when making an overall assessment of labour market conditions relative to full employment from this broad set of inputs because each piece of information requires interpretation and only provides a partial view of the labour market. This judgement is explained in the quarterly *Statement on Monetary Policy*, to provide transparency around our assessment of full employment.

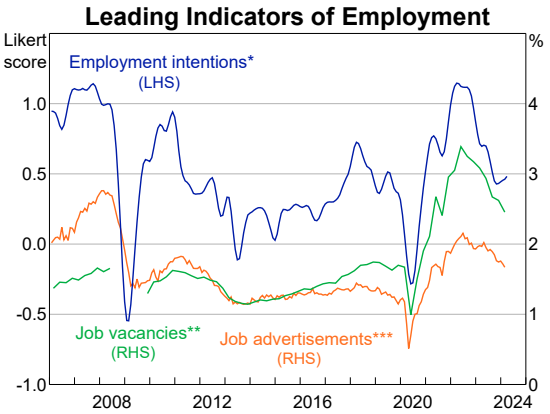
How labour market indicators inform our assessment

There are a wide range of economic indicators that capture different features of the labour market and respond in different ways to the business cycle. These indicators can be broadly summarised as primarily capturing either movements in labour demand, supply, or spare capacity. However, indicators tend to overlap categories because they will reflect both demand and supply forces. Wages growth and consumer price inflation also form an important part of the indicators analysed, though they can also reflect developments outside the labour market. Judgement is required in considering the factors that drive changes in each of these indicators.

Labour demand

Indicators such as the number of job advertisements, job vacancies and measures of firms' employment intentions from business surveys and the RBA's liaison program provide information on the demand for new employees (Graph 2). These indicators provide a relatively timely read on firms' labour demand and employment growth, helping to identify turning points in labour market conditions (Edwards and Gustafsson 2013). They also reflect the balance between labour demand and labour supply. For instance, the large increase in vacancies during the pandemic partly reflected a shortage of suitable applicants, such as the pandemic-related decline in temporary migrants affecting industries like hospitality.

Graph 2

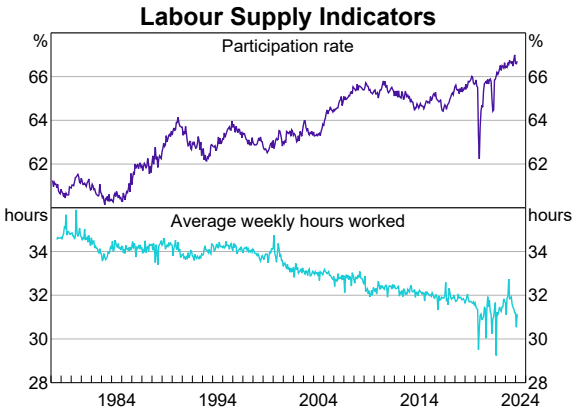


* Over the year ahead; smoothed using a 13-month Henderson trend.
** As a share of the labour force; this survey was suspended between May 2008 and November 2009.
*** As a share of the labour force.
Sources: ABS; JSA; RBA.

Labour supply

Changes in the participation rate, population growth and average hours worked affect labour supply and therefore the extent of any spare capacity (Graph 3).[6] These indicators affect the level of full employment since they determine the pool of available labour hours, and so the level of employment that is consistent with low and stable inflation. Population growth adds to labour demand, as well as supply.

Graph 3



Sources: ABS; RBA.

Movements in these indicators reflect both structural and cyclical forces. The steady increase in the participation rate over many decades reflects longer run structural trends, such as the increase in female labour force participation and an increased tendency for workers to retire later. Population growth is affected by changes to life expectancy, birth rates and migration. The decline in average hours worked reflects shifts in work preferences and an increase in the part-time share of employment associated with structural changes in the economy and labour market reforms in the 1980s and 1990s.

Labour supply also responds to the economic cycle. For example, when labour demand is strong, more people may be willing to work additional hours because wages growth tends to be stronger. In addition, more people tend to be drawn into the measured labour force when demand is strong.[7] More generally, as with other labour market indicators, it can be difficult to disentangle the cyclical and structural factors at play and obtain a clean read of the extent of labour supply that is consistent with full employment.

Labour market spare capacity

There are a number of measures of spare capacity (or labour market tightness) that are particularly useful for assessing the balance of labour demand and supply.

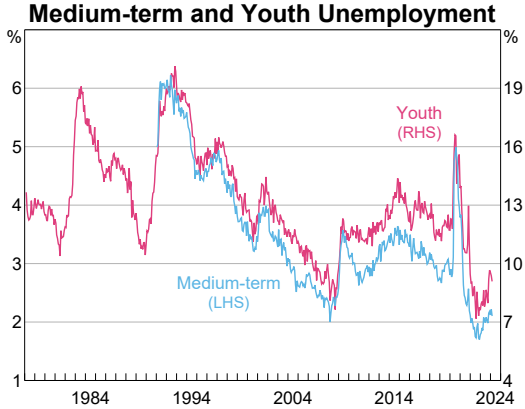
The unemployment rate has traditionally been the key measure of labour market spare capacity. However, structural trends in the labour market mean that the unemployment rate that is consistent with full employment has changed over

time and will likely continue to do so. These structural factors may be driven by changes in the composition of labour underutilisation, wage-setting practices, welfare systems and labour market regulation. There are various ways to separate these structural changes in the unemployment rate from the cyclical moves that are most relevant for monetary policy. Economic models are particularly helpful in this respect and are discussed further below.

More detailed components of unemployment add colour to the picture of spare capacity and are affected differently by cyclical and structural developments. For instance, movements in unemployment differ depending on the duration of unemployment experienced by jobseekers. In fact, movements in the rate of medium-term unemployment – those that have been unemployed for between four and 52 weeks – better reflect cyclical labour market conditions and are most relevant for wages growth, whereas the long-term unemployment rate is more related to structural factors (Ballantyne, De Voss and Jacobs 2014). The youth unemployment rate also tends to respond more to cyclical conditions (Graph 4; Dhillon and Cassidy 2018).

Graph 4

Medium-term and Youth Unemployment



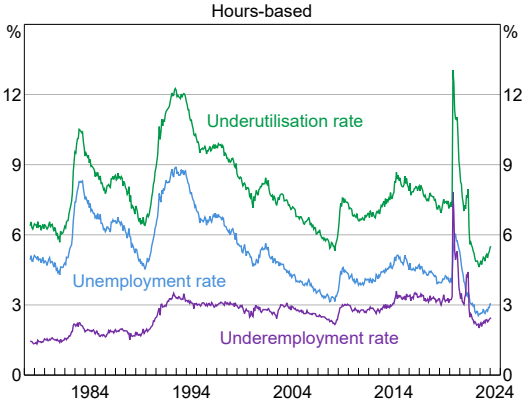
Sources: ABS; RBA.

Broader measures such as the hours-based underutilisation rate are important for a full picture of labour market spare capacity. The unemployment rate is a useful headline statistic, but it is a narrow measure, excluding workers who currently have jobs, but would like to work more hours – the underemployed. To account for the total volume of spare capacity in hours, we look at the hours-based underutilisation rate, which captures the shortfall of hours worked due to both unemployment and underemployment. Like unemployment, underutilisation measures also have structural trends that need to be considered when interpreting the data (Graph 5).

Graph 5

Labour Underutilisation

Hours-based



Sources: ABS; RBA.

Job opportunities and the rate at which people move between jobs also provide an indication of labour market tightness. The number of vacancies relative to the number of unemployed people captures the number of job opportunities for each person looking for work. An increase in this ratio indicates a tighter labour market. That could be due to higher labour demand leading to higher vacancies, or because of increasing labour shortages or skill mismatches. Rates of hiring, and involuntary and voluntary job separation can help us understand changes in the amount of spare capacity more deeply. Rates of job switching are also linked with tightness in the labour market and are positively associated with aggregate wages growth (Black and Chow 2022). Survey data that report the extent to which labour is a constraint on output for firms also provides an indication of tightness.

Wage and price indicators

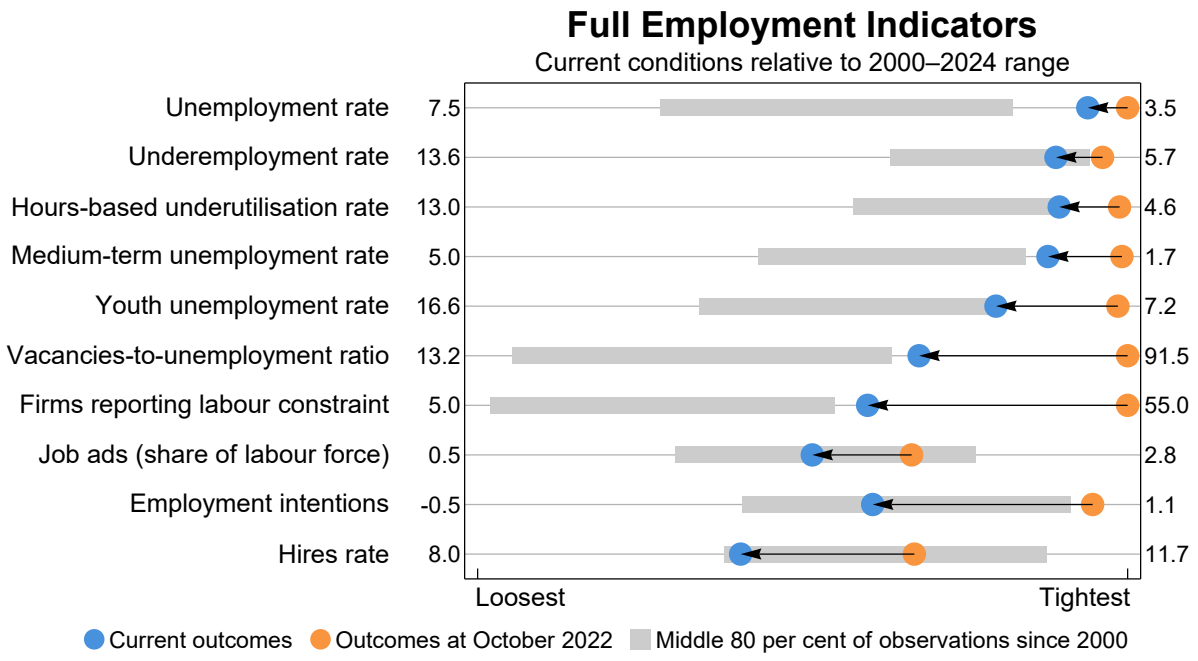
Price and wage indicators, in combination with productivity, provide useful information on the overall balance of demand and supply in the labour market. Detailed wages data can be useful to gauge the breadth of imbalance and whether particular sectors or occupations are tighter than others. Consumer price inflation outcomes are also informative in gauging the balance of demand and supply in the market for goods and services, which in turn affects conditions in the labour market. Inflation, wages and labour costs (i.e. wages accounting for productivity) are commonly used in models to generate statistical estimates of full employment (see below).

However, inflation can move for reasons other than imbalances between labour demand and supply. For instance, inflation can be affected by changes in the production of goods and services unrelated to labour markets, including disruptions in foreign supply chains for goods. The relationship between labour market conditions, wages and inflation may also be subject to lags; for example, a large share of Australian wages is set by annually reviewed award rates or by multi-year enterprise bargaining agreements, both of which can moderate the frequency of wage changes. Given these complications, some judgement is required when determining how wages growth, inflation and productivity inform an assessment of full employment.

Drawing key indicators together

Any single indicator provides only a partial view of spare capacity in the labour market. Looking at the pattern across a range of indicators provides a more comprehensive picture. Graph 6 provides a visual summary of some of the key indicators. It compares the latest observation of each indicator (blue dots) with the middle 80 per cent of observations since 2000 (grey bars) for historical context. It suggests that the labour market remains tight but has eased relative to when the labour market was very tight in late 2022 (shown as orange dots, which for many indicators are close to their tightest level on record). The easing in the labour market since late 2022 is most evident in measures that tend to be leading indicators, such as firms' employment intentions.

Graph 6



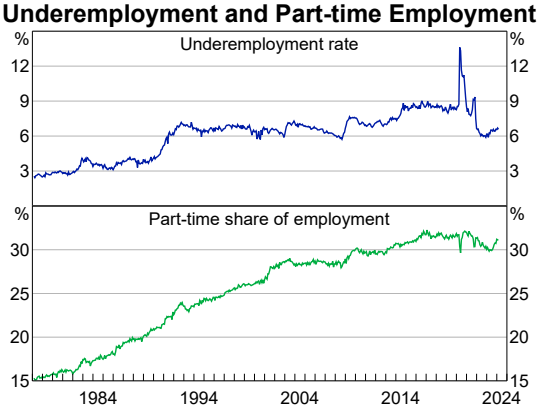
Sources: ABS; JSA; NAB; RBA.

In practice, there is no mechanical link between this summary and our overall assessment of labour market conditions relative to full employment, which is set out in the quarterly *Statement on Monetary Policy*. Although history may be a guide to finding the full employment level of these variables, there are several limitations with this approach that mean the relevant benchmark is uncertain and so judgement is required when interpreting the graph.

One limitation is that these variables may have trended up or down over time, so looking at the current level of an indicator relative to history can be misleading. Focusing on the values of these indicators when the economy was previously near full employment is also problematic since the level of full employment changes over time and is uncertain itself. For example, the underemployment rate has trended upward over time, along with the part-time share of employment (Graph 7; Chambers, Chapman and Rogerson 2021). This has occurred alongside structural changes to the Australian economy, such as the shift to a greater employment share in services industries and labour market reforms that have made it easier for firms to adjust the working hours of their employees (Bishop, Gustafsson and Plumb 2016). So the very low level of underemployment in the 1970s is not a good guide for the level of underemployment consistent with full employment today. We have models that can help us extract the cyclical signal from the trend in labour market indicators, but they are not available for every variable.

Graph 7

Underemployment and Part-time Employment



Sources: ABS; RBA.

Another reason judgement is required when making comparisons across the indicators is because the distribution of historical outcomes varies from one indicator to the next. For example, unemployment spikes upwards during downturns, but tends to move down gradually during economic expansions. Because of this, and a longer run downward trend over recent decades, outcomes of the unemployment rate tend to be located towards the right-hand side of Graph 6. This contrasts with the recent behaviour of the vacancies-to-unemployment ratio, which increased sharply as the labour market tightened. As a result, movements in this ratio have been greater in magnitude lately, while the position of typical levels of this indicator are much further to the left than for other indicators.[8]

Finally, the summary in Graph 6 should not be thought of as being static. The indicators on the graph may change as further work is done, new data sources become available or alternative data sources become better suited to illustrating the state of the labour market. Microdata are increasingly being used to unlock perspectives on the labour market that were not previously available, and more indicators built on these data could be constructed in the future.

How models inform our assessment

By exploiting historical relationships between labour market indicators, models help us synthesise information into quantitative assessments of labour market conditions. They are particularly useful for capturing the relationship between the labour market, wages growth and inflation. However, there is considerable uncertainty around these model-based assessments, as there is only so much information models can provide about unobservable concepts like full employment. Even so, models are a useful input into our overall assessment of labour market conditions.

Separating trend and cycle

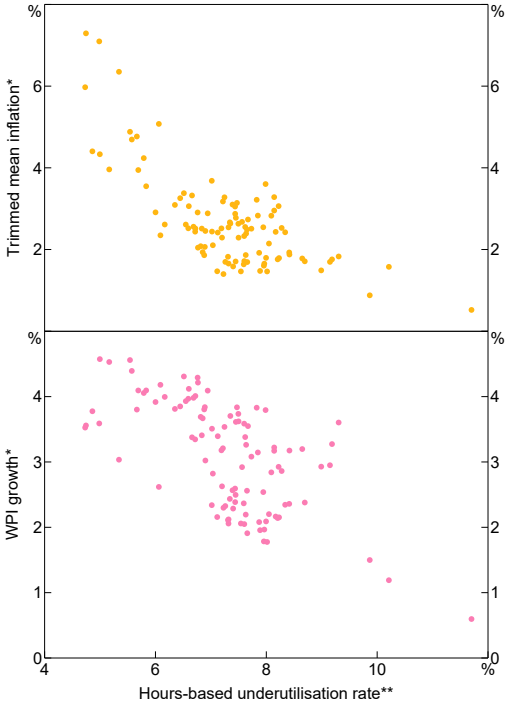
Models rely on a combination of economic theory and statistical techniques to separate spare capacity (cyclical variation in the data) from any structural trends and noise (such as measurement error). This provides a formal framework for analysing the history of a single or several labour market indicators, and the output can be cross-checked against what we know about historical developments to ensure consistency. The structural trends extracted from the data may be of economic interest themselves, but primarily allow for a cleaner read on how current conditions differ from a labour market with labour supply and demand in balance. For example, underutilisation typically ranged between 5½ per cent and 8 per cent over 2000–2024 (i.e. the light grey range in Graph 6), but our models suggest that the rate of underutilisation that can be sustained without creating inflationary pressure was at the lower end of this range at around 6–7 per cent at the end of 2023.

Most models used to assess spare capacity in the labour market exploit historical relationships between unemployment or hours-based underutilisation and other variables measuring inflationary pressures. For example, there is typically an inverse relationship between the hours-based underutilisation rate and wages growth or inflation in the short term – this is a version of the Phillips curve (Graph 8).[9] Based on this relationship, our models use movements in wages or prices to infer the gap between the hours-based underutilisation rate and its full-employment level. If we see high wages growth or upward pressure on inflation, it suggests a tight labour market with strong labour demand relative to supply, and so the current hours-based underutilisation rate is likely to be below its full-employment level. If we see low wages growth or downward pressure on inflation, it suggests that there is spare capacity in the labour market with weak labour demand relative to supply, and so the current hours-based underutilisation rate is likely to be above its full-employment level.

Graph 8

Inflation, Wages and Labour Underutilisation

1998–2023



* Six-month annualised growth rate.
** Six-month trailing average.
Sources: ABS; RBA.

The non-accelerating inflation rate of unemployment or NAIRU

Many central banks, including the RBA, have traditionally used Phillips curve models to estimate spare capacity in the labour market, in particular a type of Phillips curve model that estimates a non-accelerating inflation rate of unemployment (NAIRU).[10] The (unobservable) NAIRU is often thought of as the unemployment rate at which inflation is neither rising nor falling, and is estimated using a specific set of assumptions. A key feature is that it incorporates a role for inflation expectations into the Phillips curve; if unemployment remains too low for too long, inflation expectations will rise, which risks ingraining higher rates of inflation. In this way, any attempt to push unemployment permanently lower than the NAIRU will lead to ever increasing rates of inflation.

However, the way the NAIRU is modelled has evolved since it was introduced in the 1970s. One innovation is the extension to broader measures of spare capacity, such as the non-accelerating inflation rate of labour underutilisation (NAIRLU) that uses the hours-based underutilisation rate instead of unemployment. A more fundamental refinement has been the treatment of inflation expectations. In the form currently implemented at the RBA, the NAIRU models measure the rate of unemployment that would be consistent with actual inflation being in line with expected inflation. That is, when unemployment is at the NAIRU, the models predict that inflation will drift from its current rate towards inflation expectations and then remain stable. (The same holds for the underutilisation-based NAIRLU models.) In this framework, it is only when inflation expectations become unanchored that continually rising inflation is possible, so the 'non-accelerating' part of the name does not describe the modern application well. The models do not mechanically require unemployment above the NAIRU for inflation to fall from a high level back towards target if inflation expectations remain anchored.

Because we cannot observe the NAIRU directly, we use statistical models to estimate it based on the relationships between inflation, labour costs and the unemployment rate. If the unemployment rate declines and inflation does not increase by as much as historical relationships would suggest, then model estimates of the NAIRU will decline, all else equal. This has been broadly the case over the past two decades, with estimates of the NAIRU declining gradually by roughly 2 percentage points. In today's labour force, that equates to a little over 290,000 additional workers that can be sustainably employed.

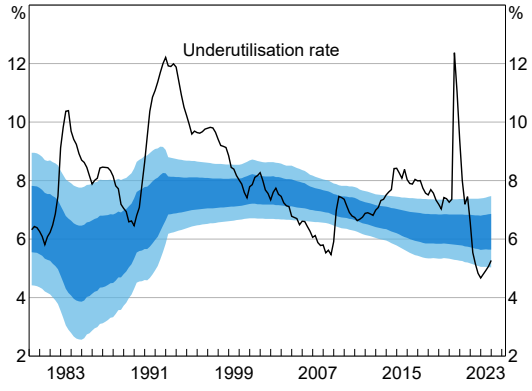
NAIRU models are a useful starting point and there is extensive literature about them; however, as with all models, there are limitations and critiques.[11] In particular, the estimates can be sensitive to the model details, are prone to revision as new data come in, and have large uncertainty around them. The structural determinants of the NAIRU are not modelled, and the models do not provide forecasts of how the NAIRU might change in future. In addition, the NAIRU models used in the RBA do not specify how inflation expectations will evolve – this is of crucial importance to the inflation outlook and is addressed in other models.

Recently developed NAIRU and NAIRLU models by the RBA take greater signal from wage outcomes over inflation outcomes and incorporate a more explicit role for productivity growth. But all of the model estimates have a wide band of uncertainty. Graph 9 shows the range of uncertainty around one particular model that feeds into our suite of NAIRLU models, which is fairly typical of the uncertainty around the central estimates of other suite models.

Graph 9

Uncertainty around Model Estimates of Full Employment*

Per cent of labour force



* Shaded areas represent one and two standard error bands for smoothed estimates of a single model, accounting for filtering and parameter uncertainty.

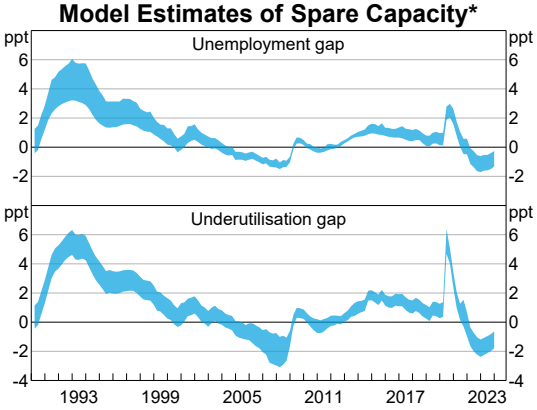
Sources: ABS; RBA.

A suite of models for inferring spare capacity

Different models will have different strengths and weaknesses, and no model sufficiently captures all dimensions of labour market spare capacity. We use a suite of models to capture a range of perspectives, which extend beyond the NAIRU and NAIRLU framework. The suite includes models developed within the RBA and models developed externally.[12] We look at model estimates of spare capacity in terms of the 'gaps' between the current unemployment and underutilisation rates and the model-based estimates of their full-employment rates (Graph 10). The estimates suggest that the labour market remains tight, but has eased relative to its peak.

Graph 10

Model Estimates of Spare Capacity*



* Blue-shaded region shows illustrative range of central gap estimates from a selection of models; estimates are subject to substantial uncertainty, as well as revision due to data and model refinements.

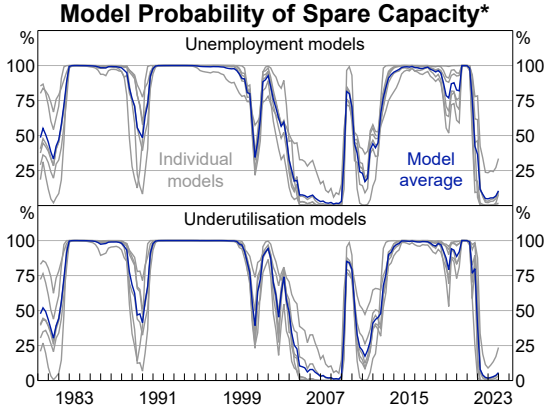
Sources: ABS; RBA; Ruberl et al (2021).

We have been further developing our modelling suite to both refine our estimates and broaden the frameworks used. For example, a recently developed model incorporates information from a wider range of labour market indicators, including leading indicators of labour demand like vacancies and job advertisements. The suite of models will continue to evolve.

The range of estimates in Graph 10 covers the central estimates from the selection of models in our suite, but does not capture the uncertainty around each estimate. To provide a view from the models that accounts for all of the most important forms of uncertainty, we can look at the implied probability in each model that there is spare capacity in the labour market (i.e. the probability that the current rate of unemployment or underutilisation is above its sustainable level; Graph 11). A probability of 50 per cent broadly accords with a labour market that is in balance, according to the models. A simple average across the models suggests that the probability that the labour market was operating with spare capacity at the end of 2023 is modest, around 10 per cent based on most of the models of unemployment and around half of that based on hours-based underutilisation.

Graph 11

Model Probability of Spare Capacity*



* The probability of the unemployment rate or underutilisation rate being higher than the model estimate of full employment, accounting for filtering and parameter uncertainty; estimates are subject to revision due to data and model refinements.

Sources: RBA; Ruberl et al (2021).

Conclusion

Assessing the level of full employment consistent with low and stable inflation is an important task for central banks. Staff at the RBA consider a wide range of inputs to form an overall assessment of the (unobservable) level of full employment. This includes using various labour market indicators, and models that combine information on labour market conditions and inflationary pressures based on economic theory. However, simply looking at the current level of indicators relative to history can be misleading and there may also be developments that models do not fully capture. As a result, careful judgement is required to weight all available information to assess how close the labour market is to full employment.

Endnotes

[*] Alexander Ballantyne and Avish Sharma are from Economic Analysis Department and Tim Taylor contributed while on secondment in Economic Group. They would like to thank Ewan Rankin, Nick Stenner, Matt Read, Tom Rosewall, Marion Kohler, David Norman, Michelle Lewis, Sue Black, Lynne Cockerell, Sarah Hunter, Chris Kent, Brad Jones, Jeff Borland and Anthony Brassil for comments on this article.

[1] Full employment has a long history in Australia and internationally, but there is no universally accepted definition and there are subtle differences between definitions used by fiscal and monetary authorities. Nonetheless, the definition used in the *Statement on the Conduct of Monetary Policy* is consistent with that used by several peer central banks.

[2] There are also other factors that can affect the amount of unemployment that occurs when the economy is at full employment, such as market power, industrial relations regulation and social support systems.

[3] For example, changes in the patterns of demand or production can require workers with a different skill set to what are currently available, which increases the structural mismatch in the labour market and lowers full employment.

[4] The Australian Government (2023) has released a White Paper setting out its 'inclusive' full employment objective – to broaden labour market opportunities and to lift the level of employment that can be sustained over time.

[5] A sustained strong labour market might permanently increase labour supply by encouraging more people into the workforce and providing opportunities to gain new skills and experience. The extent to which this happens remains an open question.

[6] People's preferred hours of work will also affect labour supply. However, detailed data on the preferred hours of work for those not in the labour force is currently not available, so it is difficult to gauge total potential hours in the economy.

[7] There are a large group of potential workers who are not counted as part of the labour force but wish to work. These individuals typically do not meet the Australian Bureau of Statistics' definition of unemployment because they are either not immediately available or not actively searching for a job. But these potential workers represent another source of labour supply and their flows into and out of the labour force in each month are large (Evans, Moore and Rees 2018; Gray, Heath and Hunter 2005). Measuring this broader group of potential workers remains a challenge.

[8] The choice of the historical range shown in Graph 6 is also a judgement call and can influence any inferences made. Increasing the historical range means the variables are more susceptible to structural trends, whereas a shorter range may mean there is less cyclical variation in the indicators.

[9] The Beveridge curve, which shows that the unemployment rate is inversely related to the vacancy rate, is the other most commonly used framework for modelling full employment.

[10] Central bank literature on the NAIRU includes: Gruen, Pagan and Thompson (1999); Cusbert (2017); Crump, Nekarda and Petrosky-Nadeau (2020); Jacob and Wong (2018).

[11] Further literature on the NAIRU includes: Gordon (1997); Staiger, Stock and Watson (1997); Espinosa-Vega and Russell (1997); Ball and Mankiw (2002).

[12] External estimates have also been used as part of the suite, primarily those produced by the OECD; however, the OECD has discontinued updating their estimates and so they are not included here.

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Cash Rate Pass-through to Outstanding Mortgage Rates

Benjamin Ung[*]

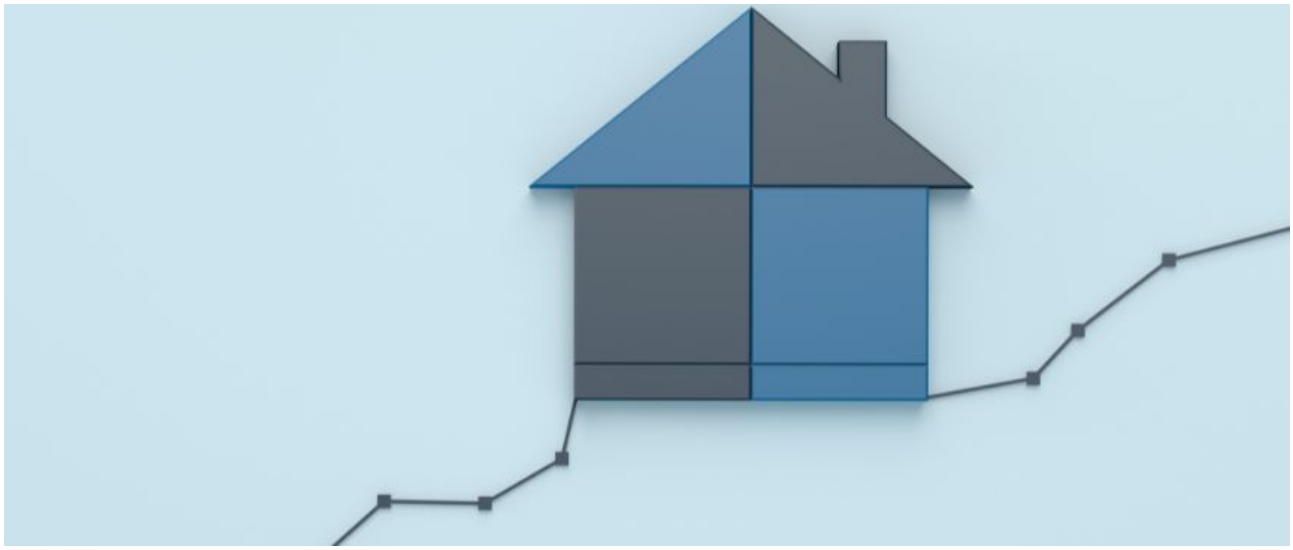


Photo: Vertigo3d – Getty Images

Abstract

The interest rate paid by outstanding mortgage borrowers increased by around 320 basis points between May 2022 and December 2023, around 105 basis points less than the cumulative increase in the cash rate over this period. This pass-through from cash rate increases to the average outstanding mortgage rate has been slower than in recent tightening episodes due to a high share of outstanding fixed-rate loans and the effects of heightened mortgage lending competition. The average outstanding mortgage rate will increase further as the remaining share of low-rate fixed-rate loans expire and reprice at higher interest rates. By the end of 2024, overall pass-through is expected to be comparable to earlier tightening episodes.

Introduction

Monetary policy transmission occurs through several different channels. One of the most well-known is the effect on household cash flows arising from the cost of debt servicing.[1] This cash flow channel is particularly evident through its impact on mortgage borrowers due to the high share of mortgage debt in Australia, and especially because most mortgagors have variable-rate loans that are responsive to changes in policy rates (Kent 2023).

Assessing the strength of this channel is therefore important for understanding how monetary policy is transmitting to the broader economy. At the same time, however, there are positive cash flow benefits to those with savings when interest rates rise, and higher interest rates provide an incentive for both borrowers and savers to save more than they otherwise would.

The RBA raised the cash rate target by 425 basis points between May 2022 and December 2023.[2]

Table 1: Cash Rate Pass-through to Outstanding Mortgage Rates

Tightening episodes	Increase in cash rate bps	Increase in outstanding mortgage rates bps	Proportion of pass-through per cent
May 2006 – Mar 2008	175	153	87
Oct 2009 – Nov 2010	175	153	87
May 2022 – Dec 2023[(a)]	425	321	76

(a) Latest available data as of December 2023.

Sources: APRA; Perpetual; RBA.

Over this period, the average outstanding mortgage rate increased by around 320 basis points. This was around 105 basis points less than the cumulative increase in the cash rate. Hence, around 75 per cent of the increase in the cash rate had passed through to the average outstanding mortgage rate, compared with nearly 90 per cent over the course of earlier tightening episodes in 2006 and 2009 (Table 1; Graph 1).

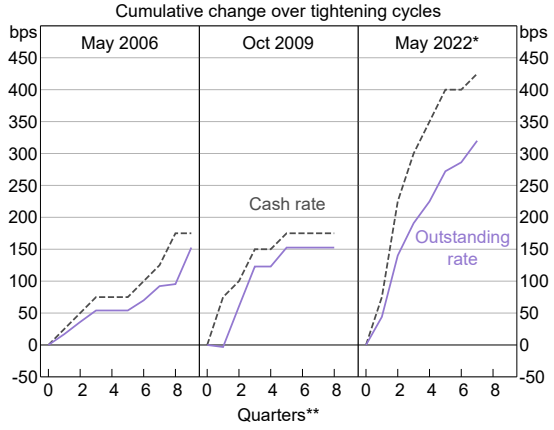
This article explores two developments that have slowed the pass-through of cash rate increases to the average outstanding mortgage rate between May 2022 and December 2023:

1. A high share of outstanding fixed-rate loans has contributed to slower pass-through compared with earlier tightening episodes in 2006 and 2009.
2. Outstanding variable rates have increased by less than the cash rate, alongside heightened competition between mortgage lenders.

Graph 1

Changes in Outstanding Mortgage Rates

Cumulative change over tightening cycles



* Latest data to December 2023.

** Quarters since first cash rate increase.

Sources: APRA; Perpetual; RBA.

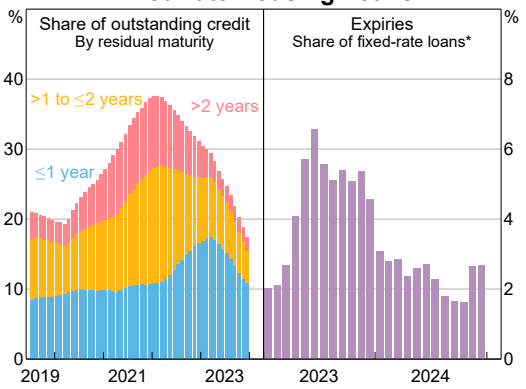
The average outstanding mortgage rate is projected to increase further as the remaining loans on low fixed rates expire and reprice at much higher interest rates. As this plays out, cash rate pass-through to the outstanding mortgage rate is expected to reach a similar proportion to that seen in previous tightening episodes.

The effect of fixed-rate borrowing on pass-through

Many borrowers took advantage of the low fixed rates on offer during the COVID-19 pandemic to lock in their mortgage repayments for a period. The very low fixed rates on offer reflected lenders' access to options to fund such products at low rates given the monetary policy settings at the time. Of particular note, unconventional policies implemented by the RBA, such as the Term Funding Facility and the yield target on the three-year Australian Government bond, supported lenders in obtaining low-cost term funding (RBA 2023a). These factors enabled lenders to price their fixed rates below the variable rates that were advertised to new borrowers (RBA 2023b). As a result, the share of fixed-rate housing loans increased substantially, from around 20 per cent of outstanding housing credit in early 2020 to a peak of almost 40 per cent in early 2022 (Graph 2). This share has since declined to around 17 per cent as of December 2023, reflecting the expiry of a significant proportion of fixed-rate loans and the very low share of new loans on fixed-rates.

Graph 2

Fixed-rate Housing Loans



* Share of fixed-rate housing loans outstanding for the major banks as at December 2022. Loans expiring beyond 2024 not available monthly.

Sources: APRA; Major banks; RBA.

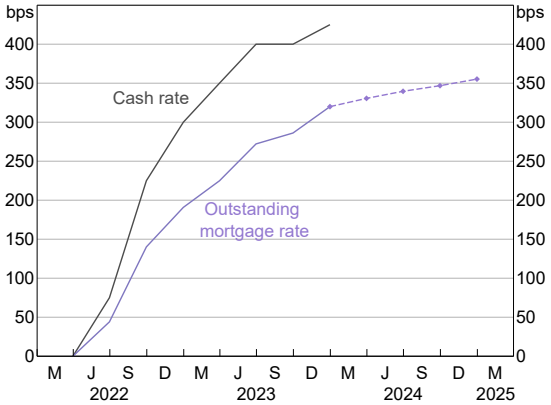
A little more than half of loans taken out at low fixed rates during the pandemic expired in 2023.[3] The pace of fixed-rate expiries was particularly elevated over the second half of 2023; fixed-rate loan expiries over the September and December quarters of 2023 each accounted for around 15 per cent of fixed-rate loans outstanding as of December 2022. The bulk of borrowers who have rolled off fixed rates have managed the transition to higher interest rates well (RBA 2023c). Most of these borrowers took out loans at low fixed rates of around 2–2½ per cent during the pandemic. These fixed-rate loans have, on average, rolled-off onto interest rates close to the outstanding variable rate (Lovicu *et al* 2023). Based on prevailing mortgage rates as of December 2023, expiring fixed-rate loans have repriced to an average mortgage rate of around 6½ per cent.

While the pace of fixed-rate loan expiries has slowed, there remains a substantial share of low-rate fixed-rate loans – around 35 per cent of the stock of fixed-rate loans that was outstanding in December 2022 – that will expire over 2024. This will contribute to a further increase in the average outstanding mortgage rate as these fixed-rate borrowers transition to much higher prevailing interest rates than they are currently paying. Under the assumption that these fixed-rate loans reprice to the current outstanding variable rate, the average outstanding mortgage rate is projected to increase by an additional 35 basis points between December 2023 and December 2024 (Graph 3). Slightly more of this increase would occur over the first half of 2024 as the pace of fixed-rate loan expiries remains more elevated over this period compared with the second half of the year. Such an outcome would ultimately result in a similar degree of overall pass-through to outstanding mortgage rates as observed in the previous two tightening episodes in 2006 and 2009, albeit over a longer period beyond the tightening phase.

Graph 3

Projected Change in Mortgage Rates*

From fixed-rate roll-off; cumulative change since April 2022



* Actual data to December 2023. Projections (dashed line) are derived based on the profile of expiring fixed-rate loan rolling-off to the average outstanding variable rate as at December 2023 (6.5%).

Sources: APRA; RBA.

By contrast with the most recent episode, fixed-rate loan expiries over the 2009 tightening episode *limited* the pass-through to outstanding mortgage rates. This is because most borrowers that took out fixed-rate loans prior to the 2009 tightening episode had fixed rates that were higher than the prevailing interest rates at the time when these fixed-rate loans expired.[4] These fixed-rate borrowers transitioned from higher fixed rates to lower prevailing rates, which meant that these expiries contributed to a lower, rather than a higher, average outstanding mortgage rate.

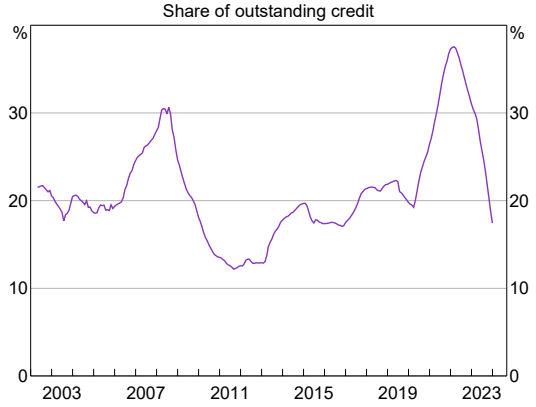
Another factor affecting pass-through is the share of new fixed-rate lending that takes place *during* the tightening phase. While few borrowers have taken out fixed rates over the current tightening episode, fixed-rate loans accounted for a material share of new lending over the 2006 tightening episode. The outstanding share of fixed-rate loans increased from around 20 per cent in May 2006 to around 30 per cent by the middle of 2008 (Graph 4). Fixed rates also tracked variable rates more closely over

the course of the 2006 tightening phase relative to other episodes. Borrowers that took out fixed-rate loans during the tightening phase therefore experienced a smaller increase in their mortgage rates, as they did not incur the full increase in mortgage rates over the tightening period. This, in turn, limited the extent of pass-through to the total outstanding mortgage rate over the 2006 tightening episode.

Graph 4

Fixed-rate Housing Loans

Share of outstanding credit



Sources: APRA; Perpetual; RBA.

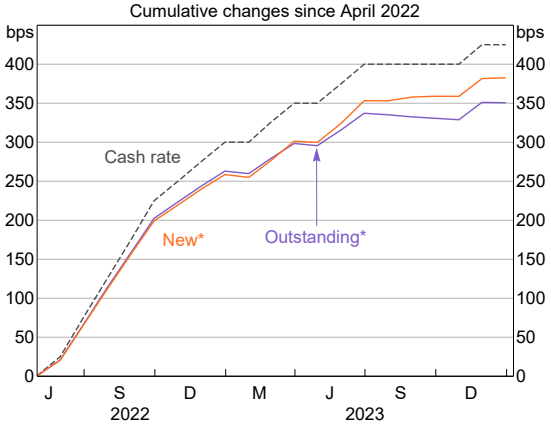
The effect of funding conditions and mortgage lending competition on pass-through

The recent period of heightened mortgage lending competition – particularly over the second half of 2022 and early 2023 – has contributed to the average mortgage rate paid on outstanding variable-rate loans increasing by around 75 basis points less than the cash rate between May 2022 and December 2023 (Graph 5). Since the start of cash rate tightening, many borrowers have sought out lower mortgage rates by negotiating with their existing lender or by refinancing with another lender. At the same time, lenders have been more willing to accommodate requests to lower existing mortgage rates, particularly to retain good quality borrowers. The average rate on *new* variable rate loans increased by around 40 basis points less than the cash rate between May 2022 and December 2023, as lenders offered mortgage rates at lower spreads to the cash rate to attract new borrowers.

Graph 5

Changes in Variable Housing Loan Rates

Cumulative changes since April 2022



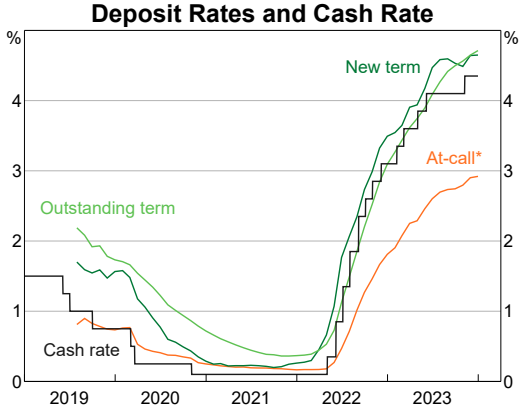
* Actual interest rates paid on all outstanding and newly funded variable-rate housing loans.

Sources: APRA; RBA.

Lending competition for variable-rate mortgages increased over the second half of 2022 as a sustained willingness by banks to compete for mortgage loans at the time coincided with a slowing in housing credit growth. At the same time, banks had access to cheap and abundant funding, including deposits. Deposit funding from households and businesses grew strongly during the pandemic, which contributed to a more subdued increase in banks' overall funding costs than would have otherwise been the case (ACCC 2023). The interest rate paid on at-call deposits, which makes up around 65 per cent of all deposits, increased by around 160 basis points less than the cash rate from May 2022 to December 2023 (Graph 6). These lower funding costs allowed banks to offer more competitive pricing, especially at the start of the current tightening episode. This was particularly the case when compared with non-bank lenders with no access to deposit funding.

Graph 6

Deposit Rates and Cash Rate



* Excludes deposits in housing loan offset accounts; includes non-interest bearing deposits.

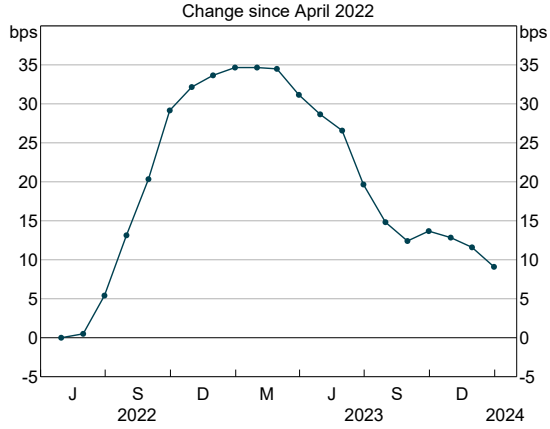
Sources: APRA; RBA.

Heightened lending competition was evident in lenders offering cashback deals of between $2,000 and $5,000 to attract both new and refinancing borrowers. Lenders also increased the discounts offered on their advertised variable lending rates (relative to benchmark standard variable rates). The average increase in discounts on these advertised rates peaked at around 35 basis points around the start of 2023 (Graph 7). These measures provided an incentive for many existing borrowers to seek out a lower mortgage rate by negotiating with their existing lender or by refinancing externally.

Graph 7

Average Discount on Advertised Variable Rates*

Change since April 2022



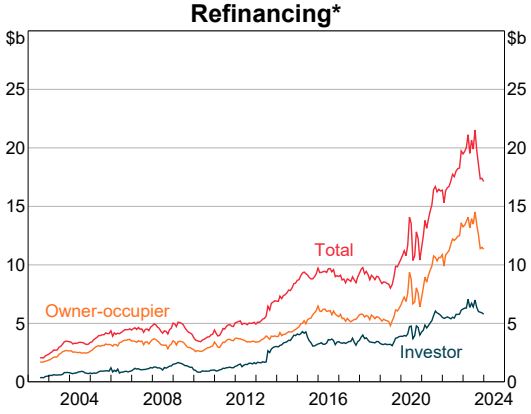
* Discounts to benchmark standard variable rates. Advertised rates are for basic principal-and-interest products offered for LVR <80% borrowers at large housing lenders.

Sources: Banks' websites; CANSTAR; RBA.

Signs of easing competition have emerged since the start of 2023. Most lenders withdrew their cashback offers in the first half of 2023 and reduced the discounts offered on their advertised variable lending rates. While the average variable rate on new loans increased by slightly more than the cash rate over some periods, the cumulative increase in the average new variable rate over the current tightening phase was still around 40 basis points less than the cash rate as at December 2023 (RBA 2023b). Despite some signs of easing competition, many lenders have generally remained willing to negotiate discounts to retain existing borrowers. External refinancing activity has also remained at elevated levels after increasing sharply over the second half of 2022 (Graph 8).

Graph 8

Housing Loan Commitments for External Refinancing*



* Seasonally adjusted and break-adjusted.

Sources: ABS; RBA.

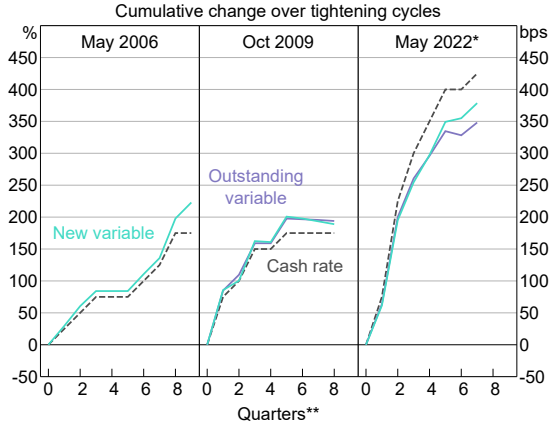
Over the most recent tightening episode, banks' average funding costs have increased by a little less than the cash rate (De Zoysa, Dunphy and Schwartz 2024; Carse, Faferko and Fitzpatrick 2023). By comparison, tighter funding conditions emerged during the 2006 and 2009 tightening phases due to increased volatility in financial markets and a structural shift in demand by the banks for more stable funding sources such as deposits and long-term wholesale funding.[5] Higher funding costs were subsequently passed through to existing borrowers and resulted in the average mortgage rate on outstanding variable-rate loans increasing by more than the cash rate during these earlier tightening episodes (Graph 9). Lenders passed through these costs to their variable-rate borrowers

in addition to passing through the increases in the cash rate. As a result, variable rates increased by more than the cash rate in the latter stages of the tightening phases in 2006 and 2009, leading to more pass-through to the overall outstanding mortgage rate.

Graph 9

Pass-through to Variable Lending Rates

Cumulative change over tightening cycles



* Latest data to December 2023.

** Quarters since first cash rate increase.

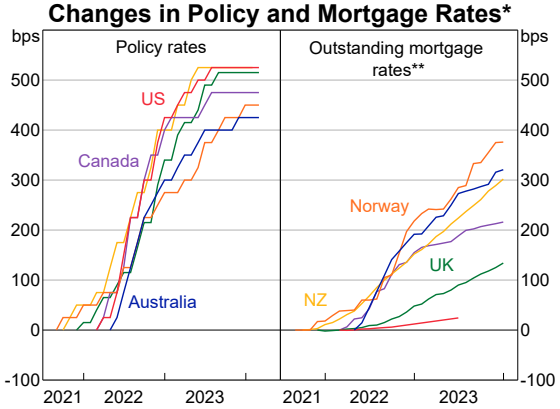
Sources: APRA; Perpetual; RBA.

Pass-through from mortgage rates to total scheduled mortgage payments

Despite slower pass-through to outstanding mortgage rates over the current tightening episode, the flow through of a higher cash rate to housing mortgage rates has still been an effective transmission channel for monetary policy in Australia. The relatively high share of variable-rate mortgages in Australia has meant that the average outstanding mortgage rate had increased by more than in other developed peer economies such as the United States, New Zealand and Canada as of December 2023, despite a smaller increase in policy rates in Australia (Graph 10; Kent 2023).[6] Housing mortgage payments have increased considerably as a share of household disposable income, even though slower pass-through to mortgage rates than previous cycles has meant that the aggregate repayment burden faced by mortgagors has – so far – increased by less than otherwise.[7]

Graph 10

Changes in Policy and Mortgage Rates*



* Cumulative basis point increase in the policy rate and average outstanding mortgage rate relative to the month immediately preceding first policy rate increase since the onset of the pandemic.

** Data for the US is interpolated between September 2022 and June 2023, remaining data to December 2023.

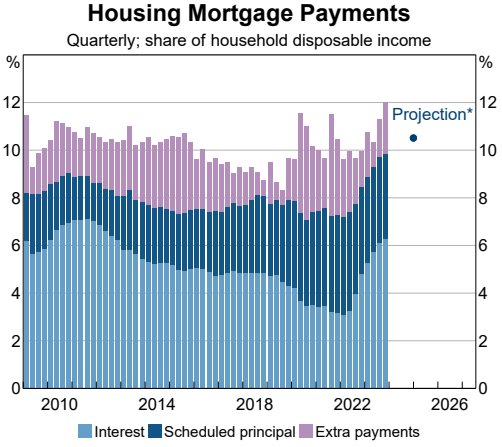
Sources: APRA; Black Knight; central banks; RBA.

Total scheduled household mortgage payments (comprising both interest and scheduled principal payments) have increased to around 10 per cent of household disposable income as of December 2023, exceeding the estimated previous historical peak in 2008 (Graph 11). These scheduled mortgage payments are expected to increase further to reach around 10½ per cent of household disposable income by end-2024 as more fixed-rate loans expire and reprice at higher interest rates. While this suggests a significant increase in household mortgage payments over the current tightening phase, this article does not consider other forms of household debt such as personal or small business loans. These forms of household debt also affect households' cash flows, although they account for a much lower share of household income compared with a decade prior (Kohler 2020).[8]

Graph 11

Housing Mortgage Payments

Quarterly; share of household disposable income



* Projections incorporate fixed-rate roll off to variable rates assuming a cash rate of 4.35 per cent.

Sources: ABS; APRA; RBA.

Conclusion

The increase in the average outstanding mortgage rate relative to the cash rate has been slower over the current tightening episode than in some previous tightening phases. This has been due to the high share of loans at very low fixed rates taken out during the pandemic and the effect of elevated mortgage lending competition on variable-rate mortgages. The average outstanding mortgage rate relative to the cash rate is expected to increase further as more fixed-rate loans expire. As a result, the extent of pass-through by the end of 2024 is anticipated to be similar to previous tightening episodes.

Endnotes

[*] The author is from Domestic Markets Department. A version of this article was prepared for the Melbourne Money and Finance Conference in February 2024. The author would like to thank Peter Wallis for his help with this article.

[1] Higher interest rates have lowered households' net interest income as aggregate household debt is much larger than household sector holdings of interest-earning assets (Kent 2023); the cash flow channel for households is best thought of as the net effect of changes on debt servicing costs for indebted households and interest income for lender households.

[2] Data figures referenced in this article are up to December 2023.

[3] As a share of fixed-rate loans outstanding as of December 2022.

[4] Most fixed-rate loans were taken out in early 2008, with the fixed-rate share peaking around 30 per cent in the March quarter. The fixed rates taken out during this period were significantly higher than the new lending rates that prevailed over the course of the 2009 tightening episode, consistent with the higher interest rate environment prior to the global financial crisis.

[5] The shift in funding sources was partly motivated by changes to regulatory requirements that incentivised banks to secure more stable and longer term funding (Senate Economics References Committee 2012).

[6] A higher share of variable-rate mortgages suggests that the cash flow channel is stronger in Australia, although other channels of monetary policy transmission are likely to be stronger in peer economies.

[7] Higher mortgage rates have also affected economic conditions through other channels, including by influencing the decisions of new prospective borrowers around whether and how much to borrow: see Kent (2023).

[8] Interest payments on overall household debt – including both mortgage debt and consumer credit products – remain below their estimated historical peak as a share of total household disposable income, largely owing to a significant decline in the use of consumer credit since 2008: see RBA (2024).

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Bank Funding and the Recent Tightening of Monetary Policy

Venura De Zoysa, Jessica Dunphy and Christopher Schwartz[*]

Photo: assalve – Getty Images

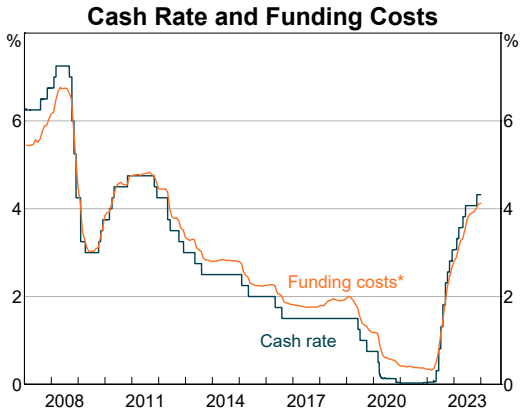
Abstract

Banks' funding costs have risen substantially since early 2022, driven by increases in the cash rate. This article explains how increases in the cash rate passed through to banks' funding sources and how banks adjusted their funding mix. All non-equity sources of bank funding became more expensive over the hiking phase. Banks increased rates on term deposits by more than at-call deposits. Within at-call deposits, banks increased rates most for those savings accounts with conditions attached. Further, banks' share of funding from term deposits grew and banks issued more debt as the Term Funding Facility started to mature.

Introduction

Bank funding costs are important in the transmission of monetary policy because the cost of funding is a key determinant of the rates that banks offer on loans to households and businesses (Brassil, Cheshire and Muscatello 2018). Bank funding costs also represent income to the entities providing the funding to banks, including households with deposits at banks. Tighter monetary policy has increased banks' funding costs significantly since early 2022. From February 2022 to December 2023, non-equity funding costs increased by around 380 basis points, while the cash rate increased by 425 basis points (Graph 1).

Graph 1

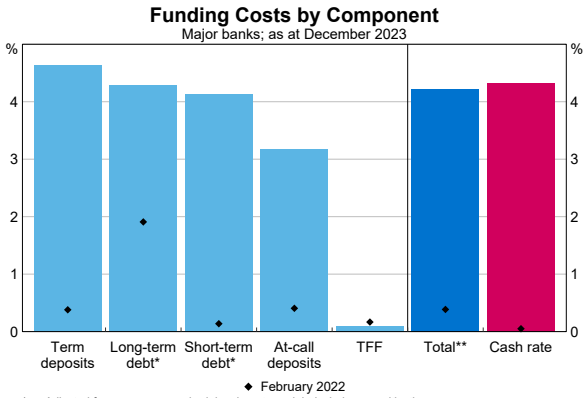


* RBA estimates of overall outstanding hedged debt and deposit costs for the major banks; to December 2023.

Sources: ABS; APRA; ASX; Bloomberg; LSEG; major bank liaison; major banks' websites; RBA; Securitisation System; US Federal Reserve.

Monetary policy affects the costs of the components of bank funding primarily through its influence on a range of interest rates in the economy (Carse, Faferko and Fitzpatrick 2023). Banks obtain funding from retail deposits, wholesale deposits, wholesale debt (including securitisations) and equity (Graph 2). In recent years, banks also sourced low-cost funding from the RBA's Term Funding Facility (TFF) (Alston *et al* 2020).

Graph 2



* Adjusted for cross-currency hedging; long-term debt includes securitisation.
** Adjusted for whole-book and replicating portfolio hedges.

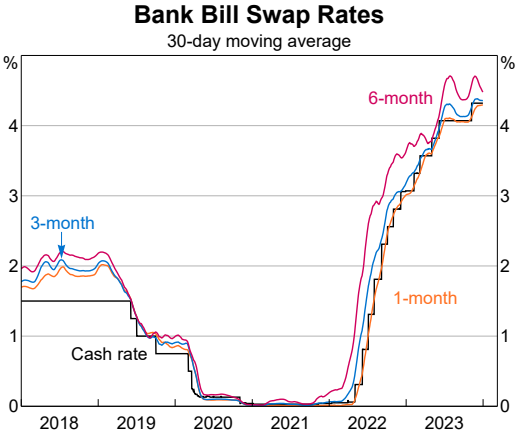
Sources:APRA; ASX; Bloomberg; LSEG; major bank liaison; RBA.

Bank bill swap rates (BBSW), which capture the cost of short-term debt in wholesale markets for major Australian banks at maturities from one to six months, are key reference rates for bank funding costs. This is because:

- banks use these short-term debt instruments as part of their funding mix
- interest rates on banks' longer-term funding liabilities are often linked back to BBSW – either directly in the case of floating-rate liabilities, or indirectly via hedges for fixed-rate liabilities.

Since February 2022, BBSW rates have increased by approximately the same amount as the cash rate (Graph 3). BBSW rates are heavily influenced by the cash rate, including expectations of future changes in the cash rate. BBSW rates are also affected by changes in bank credit risk, term premia and investor demand for short-term bank debt (Black and Titkov 2019).

Graph 3



Sources: ASX; RBA.

Drivers of bank funding costs

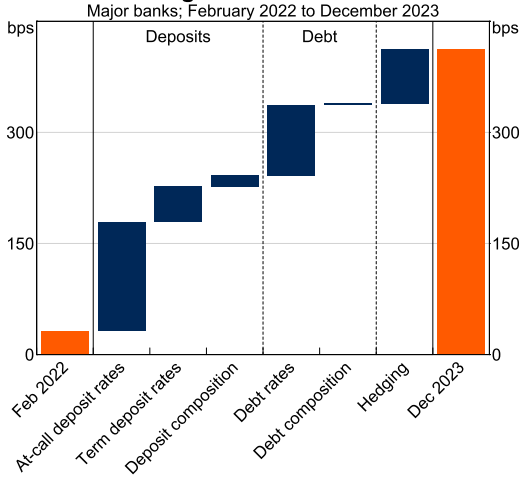
Over 2022 and 2023, increases in the cash rate were the primary driver of bank funding costs. The cost of short-term debt and term deposits increased by around the same amount as the cash rate. By contrast, the interest rate paid on at-call deposits and on long-term debt increased by less than the cash rate. Banks increased rates on certain at-call accounts (typically 'bonus' saver accounts with conditions, or accounts for new customers with introductory offers) by about the same amount as the cash rate. However, rates on other at-call deposits were increased by less. At-call deposits include transaction accounts on which banks pay little or no interest. By the end of 2023, around half of the TFF funding drawn down by major banks had matured and was replaced by more costly sources of funding, contributing around 5 basis points to the increase in bank funding costs. Some of this increase flowed through earlier to funding costs because some banks had hedged their fixed-rate TFF funding back to floating rates, which rose as the cash rate rose.

Most of the increase in funding costs owed directly to the higher rates paid on each funding component (Graph 4). Less than 20 basis points of the increase in overall funding costs owed to changes in funding composition (such as when customers shifted from lower- to higher-rate deposit products).

Graph 4

Funding Cost Contributions*

Major banks; February 2022 to December 2023



* RBA estimated outstanding rate; costs include effect of interest rate hedges; values may not sum due to rounding.

Sources: ABS; APRA; ASX; Bloomberg; LSEG; major bank liaison; major banks' websites; RBA; Securitisation System; US Federal Reserve.

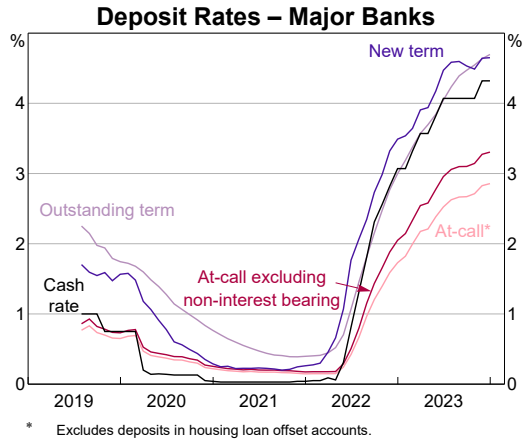
Hedging of fixed-rate liabilities back to floating rates linked to BBSW has added to funding costs over the hiking phase, contributing around 70 basis points of the 380 basis point increase in non-equity funding costs between February 2022 and December 2023. Banks use interest rate swap contracts to smooth the effect of changes in interest rates on their margins (see Box A). Hedging typically adds to funding costs in a hiking phase because banks convert their fixed-rate payments, which would otherwise remain unchanged, into variable-rate payments (such as BBSW) that increase when the cash rate rises. When interest rates decline, such as prior to the pandemic, banks' hedging activities typically reduce funding costs.

Deposit costs

Banks increased interest rates on interest-bearing deposits over the hiking phase, with the degree of pass-through differing across products (Graph 5). Rates on term deposits, where customers invest funds for a fixed period and interest rate, increased by about the same amount as the cash rate alongside similar moves in BBSW. For at-call deposits, which depositors can withdraw at any time, pass-through was more varied. Banks increased rates by more for savings accounts (e.g. 'bonus' savers or online-only savings accounts) or accounts with introductory offers than they did for everyday transaction accounts, many of which do not pay any interest. Effective rates on offset deposit accounts linked to mortgages increased with housing lending rates.[1]

Graph 5

Deposit Rates – Major Banks



* Excludes deposits in housing loan offset accounts.

Sources: APRA; RBA.

Overall, the average interest rate on total deposits excluding offset accounts increased by 325 basis points over the hiking phase, around 75 per cent of the total increase in the cash rate. This degree of pass-through is within the broad range of outcomes observed in past hiking phases in Australia. The level of pass-through over the current hiking phase in Australia has been higher than in other peer economies (see Box B).

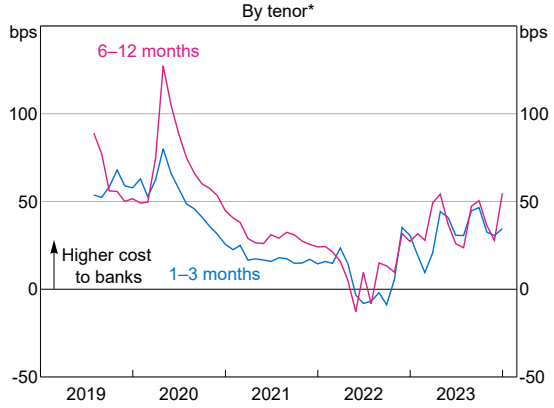
Term deposits

Banks have increased rates paid on new term deposits by around 435 basis points since February 2022, slightly more than the cash rate. BBSW is typically the reference rate for term deposits, as it is the price at which banks could otherwise borrow funds in wholesale money markets (Black and Titkov 2019). The spreads between term deposit rates and BBSW has widened from lows in 2022 (Graph 6). The wider spread could reflect banks seeking term deposits as a stable funding source when low-cost funding from the TFF started to mature (see below). Increases in new term deposit rates have flowed through to outstanding term deposit rates, which have increased by around 430 basis points over the hiking phase.

Graph 6

New Term Deposit Spread to BBSW

By tenor*



* Spreads to reference tenors (3-month and 6-month BBSW).

Sources: APRA; ASX; RBA.

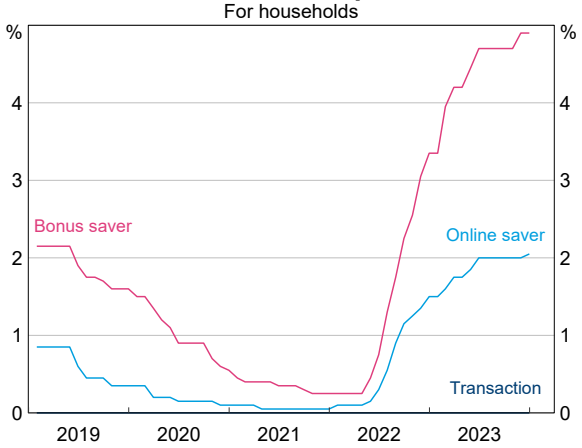
At-call deposits

The average rate on outstanding at-call deposits excluding offset accounts has increased by around 275 basis points since February 2022. At-call deposits (including those that pay no interest) comprise around three-quarters of total deposits. In its inquiry into retail deposits, the Australian Competition and Consumer Commission (ACCC) found that banks have been strategic in passing on rate increases in such a way as to limit the increase in the cost of their overall deposit funding – raising rates more on savings products with conditions and time-limited introductory offers than on standard deposit products (Graph 7; ACCC 2023). Rates on standard online savings accounts have increased by less than bonus savers, and banks continue to pay little to no interest on most transaction accounts.

Graph 7

Advertised At-call Deposit Rates

For households



Sources: Major banks' websites; RBA.

The ACCC noted that this pricing strategy helps banks attract or retain deposit funding at a lower cost than would otherwise be the case (ACCC 2023). On average, around a quarter of total funds in bonus saver accounts do not meet the conditions for the 'bonus' rate each month. The ACCC also found that there is a high degree of customer inertia around switching banks. It recommended measures to increase competition and transparency of household deposit pricing, such as requiring banks to provide more information on available deposit rates and notifying customers who may be at risk of losing their conditional bonus rate.

Households with mortgages may also have access to an offset account, which is an attractive savings vehicle (La Cava and Wang 2021). Offset accounts are at-call deposit products linked to mortgages, where the offset account balance is offset against the loan principal and the borrower does not pay interest on that offset portion of the loan. Therefore,

offset accounts in effect earn the mortgage rate. Moreover, this return is not taxed (unlike interest received from other deposit accounts). Offset account balances currently comprise around 10 per cent of bank deposits.

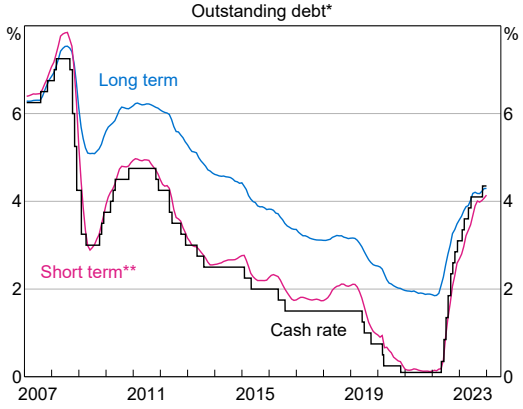
Wholesale debt costs

The cost of issuing new short-term and long-term debt has risen over the hiking phase, increasing outstanding funding costs as maturing bonds are replaced with higher-cost new issuance. The increase in debt costs have contributed around 100 basis points to the increase in non-equity funding costs. The outstanding rate paid on short-term debt (maturing within 12 months) increased by around 400 basis points. The outstanding rate on long-term debt, by contrast, increased by 245 basis points because the stock of major bank long-term debt turns over more slowly given that the weighted average maturity is around four years (Graph 8; RBA 2018).

Graph 8

Wholesale Debt Costs – Major Banks

Outstanding debt*



* Adjusted for cross-currency hedging.
** Includes intragroup and non-resident deposits.
Sources: ABS; APRA; Bloomberg; LSEG; RBA; US Federal Reserve.

The effect of higher interest rates flows through to banks' overall funding costs more quickly than outstanding debt turns over because banks hedge their fixed-rate funding and issue floating rate debt in capital markets. Banks hedge fixed-rate debt by swapping fixed-rate payments into variable-rate payments (often BBSW), which closely match interest receipts on their variable-rate loans (see Box A).

Funding costs and lending rates

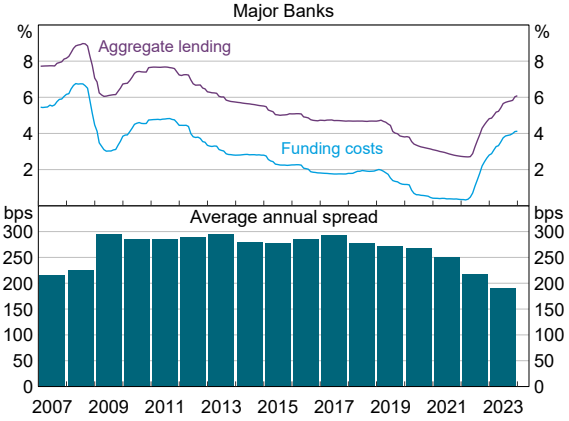
Banks' funding costs flow through to the price of credit, as Australian banks typically set interest rates on loans based on the cost of funding these loans.[2] Outstanding mortgage rates increased by around 320 basis points between May 2022 and December 2023, 45 basis points less than the increase in funding costs over the same period (Ung 2024). Rates on outstanding business loans increased by a little more than funding costs (RBA 2024). Banks price mortgage rates at a spread above funding costs and that spread decreased over the hiking phase as mortgage competition increased. The prevalence of low-rate fixed-rate mortgages also held down the average mortgage rate paid.

In the two years to December 2023, the spread between lending rates and funding costs declined 60 basis points to around 190 basis points, continuing the decline since 2017 (Graph 9). Despite these recent declines, the lending spread (the difference between lending rates and funding costs) in Australia has been relatively stable within a range compared with other jurisdictions (Brassil 2022). This relative stability is partly explained by Australian banks' use of hedging to reduce interest rate risk. In countries such as the United States, where hedging is less prevalent and mortgages have long-term fixed rates, banks are more likely to experience yield compression and expansion through economic cycles (Brassil 2022).

Graph 9

Lending Rates and Funding Costs*

Major Banks



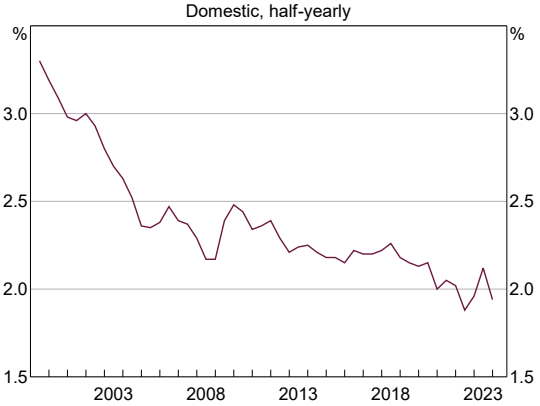
Sources: ABS; APRA; ASX; Bloomberg; CANSTAR; LSEG; major bank liaison; major banks' websites; RBA; Securitisation System; US Federal Reserve.

Decreases in the lending spread over the last five years have been a key driver of the decline in net interest margins (NIMs) (Graph 10). The NIM is the difference between interest income and interest expenses, divided by interest-earning assets.[3] Although major bank NIMs increased modestly in 2022, they have more recently declined below their pre-pandemic level. These banks cited higher wholesale funding costs, changes to their funding mix to higher-rate products and increasing mortgage competition as some reasons for the decline.[4]

Graph 10

Net Interest Margin – Major Banks*

Domestic, half-yearly



* Data for a given period relate to banks' public profit reports released in that half; IFRS basis from 2006, AGAAP prior; excludes St George Bank and Bankwest prior to the first half of 2009.

Sources: Banks' financial reports; RBA.

Funding mix

The composition of major banks' funding has shifted over the hiking phase (Graph 11). The TFF, which comprised around 4.5 per cent of total funding at the peak of its use, started to mature in early 2023. Deposits have shifted towards term deposits as interest rates increased, and banks have returned to issuing higher volumes of wholesale debt.

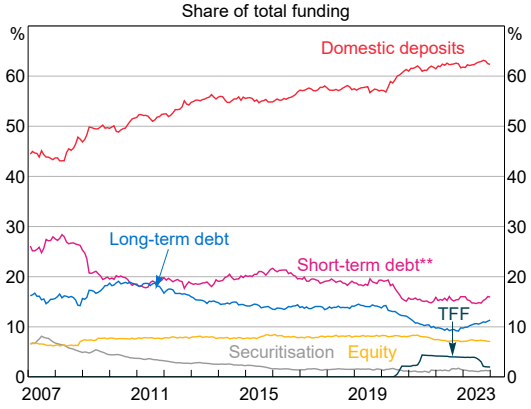
The TFF was introduced, alongside other policy support measures in response to the pandemic, to provide low-cost three-year funding to banks and to provide banks with an incentive to increase lending to businesses (Kent 2021). The TFF lowered banks' funding costs largely because it was used to replace more expensive wholesale debt funding. The TFF increased the supply of exchange settlement (ES) balances, which qualify as high-quality liquid assets (HQLA). Because the majority of TFF funding was collateralised with securities that do not qualify as HQLA, the TFF increased the supply of HQLA as these non-HQLA securities were exchanged for ES balances. Consequently, the TFF supported banks' regulatory liquidity ratios. The maturity of TFF funding has the opposite effect on banks' regulatory liquidity ratios, as ES balances (HQLA) are repaid in exchange for non-HQLA collateral.

By the end of December 2023, around $84 billion in TFF funding had matured, with the remaining $104 billion set to mature by mid-2024 (Graph 12). Banks have managed their liquidity positions well in advance of TFF maturities. For example, most large Australian banks are subject to the liquidity coverage ratio, which requires banks to hold HQLA sufficient to cover their estimated net cash outflows during a 30-day period of stress (RBA 2015). These large banks have sharply increased their holdings of government bonds (which, like ES balances, also qualify as HQLA) by around $125 billion since early 2022, alongside strong issuance of wholesale debt (Batchelor and Roberts 2024). Similarly, these banks have managed their net cash outflows by increasing their share of term funding such as term deposits (see below), therefore reducing the amount of HQLA they are required to hold to meet regulatory requirements.

Graph 11

Funding Composition – Major Banks*

Share of total funding

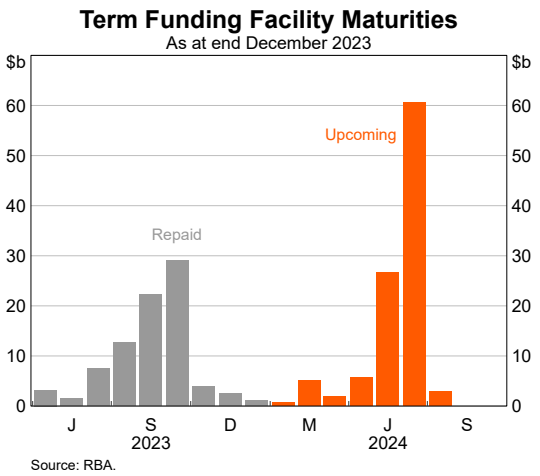


* Adjusted for movements in foreign exchange rates; tenor of debt is estimated on a residual maturity basis.

** Includes deposits and intragroup funding from non-residents.

Sources: ABS; APRA; Bloomberg; LSEG; RBA.

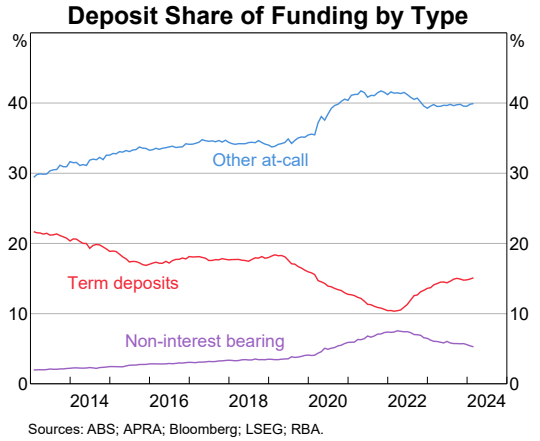
Graph 12



Source: RBA.

Deposits are the largest component of bank funding. Banks have increased their share of funding from deposits by about ½ percentage point since February 2022, as growth in term deposits has more than offset the decline in at-call deposits. The desire among banks to attract more term funding as the TFF expired was reflected in the larger increases in rates on term deposits relative to at-call products as the cash rate increased. Customers took advantage of the higher rates on term deposits as term premia increased. Over the hiking phase, the term deposit share of total funding rose to around 15 per cent, although that remains well below pre-pandemic levels (Graph 13). The share of at-call deposits, particularly those that pay no interest, declined steadily over 2022 and 2023.

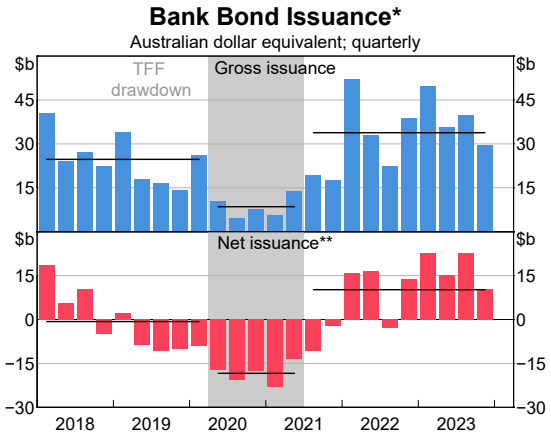
Graph 13



Sources: ABS; APRA; Bloomberg; LSEG; RBA.

Banks issued a historically large $300 billion in bonds over the tightening phase in favourable market conditions, increasing their long-term debt funding share by around 2¼ percentage points. This followed a period of very low gross issuance over the pandemic, as banks drew down on the TFF. Since then, net issuance has turned positive, largely driven by major banks increasing bond issuance as the TFF started to mature (Graph 14). Overall, short-term debt issuance has remained fairly stable, although it picked up a little over 2023 around TFF maturities. The share of funding from long- and short-term debt remains around 6 percentage points below its pre-pandemic level.

Graph 14



* Horizontal lines show average quarterly issuance for different periods.
** Net issuance calculation includes maturities to date.
Sources: Bloomberg; Private Placement Monitor; RBA.

Conclusion

Monetary policy tightening since February 2022 has increased major banks' non-equity funding costs by around 380 basis points. The increase in costs was broad-based, although rates paid on term deposits and short-term wholesale debt increased by more than those paid on at-call deposits. Funding costs have increased a little more than lending rates in aggregate, compressing the lending spread and banks' NIMs. Banks have shifted their funding composition towards term deposits and issued new debt as the TFF has started to mature.

Box A: The role of hedging in funding costs

When banks take on liabilities to fund themselves, they also take on various forms of risk. Australian banks' assets are mostly variable-rate loans for which rates adjust quickly after changes in the cash rate, whereas their liabilities include fixed-rate funding (such as term deposits, transaction accounts that pay little to no interest, and some forms of term debt) that are slower to reprice. This mismatch in interest rate sensitivity exposes banks to interest rate risk – if the cash rate falls, the interest income banks earn on their loans will fall more quickly than the interest they pay to their creditors, reducing their NIMs. Australian banks also raise funding offshore in foreign currencies. Offshore debt issuance gives banks access to deeper, diversified funding markets, but it can also expose them to foreign exchange risk, whereby any unhedged currency movements affect the cost of servicing this debt in Australian dollar terms (Johnson 2022).

Hedging is a way for banks to mitigate these risks, reducing the influence of interest rates or exchange rates on their NIMs and thereby profitability. There are three main types of hedges that banks may use:

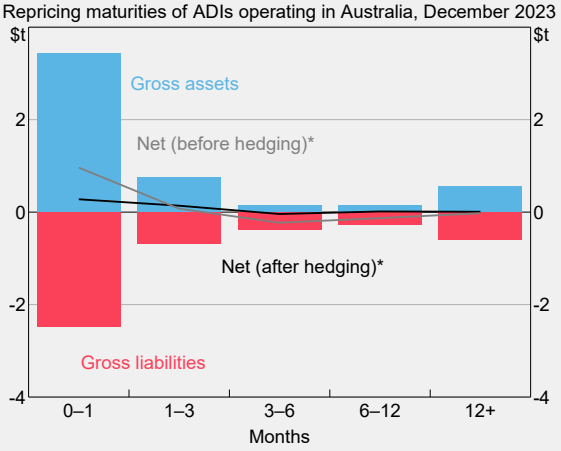
- **Replicating portfolio hedge.** Deposit accounts that pay zero or near-zero interest rates comprise a significant share of banks' deposit funding. These deposits are classified as fixed-rate funding because they are insensitive to interest rates: banks are unwilling (or unable) to reduce their rates further and do not raise rates on these accounts when other interest rates rise. This exposes banks to interest rate risk. To offset this risk, banks often use interest rate swaps, receiving a fixed-rate cashflow and paying a variable-rate cashflow. This 'replicating portfolio' of a rolling portfolio of receive-fixed, pay-floating interest rate swaps makes the effective interest rate associated with these deposits move with short-term market interest rates, like the interest banks receive on assets (Berkelmans and Duong 2014).
- **Whole-book hedge.** Banks use a whole-book hedge to reduce interest rate risk across their entire balance sheet (Graph A1; RBA 2023). This involves comparing the mismatch in fixed- and variable-rate funding between assets and liabilities across different repricing maturities and then using interest rate swaps to better align interest rate sensitivity across both sides of the balance sheet.
- **Cross-currency hedge.** Banks that issue foreign-denominated debt offshore generally use cross-currency swaps to hedge any foreign exchange risk (Atkin and Harris 2023). In a cross-currency swap, counterparties swap both principal and interest rate streams in one currency for another (Kent 2018). This allows domestic banks to swap their foreign currency principal and interest obligations into Australian dollars, at Australian short-term interest rates, providing banks with protection against movements in exchange rates and differences in interest rates between countries.

In the short term, hedging might subtract from banks' funding costs if interest rates fall, or add to costs if interest rates rise, compared with the alternative of not hedging. For example, in the current tightening phase, hedging has added to funding costs (Graph A2). Over the cycle, hedging reduces fluctuations in bank NIMs. Australian banks appear to make greater use of hedging than their international peers, possibly due to the greater role of variable-rate lending in Australia.

Graph A1

Mismatch of Assets and Liabilities

Repricing maturities of ADIs operating in Australia, December 2023



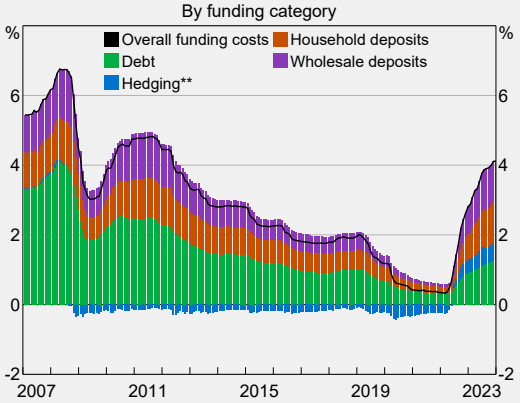
* Interest rate swaps only.

Sources: APRA; RBA.

Graph A2

Major Banks Funding Costs*

By funding category



* RBA estimates of overall outstanding hedged debt and deposit costs for the major banks; to December 2023.

** Interest rate swap hedges only; adjustments for cross-currency hedges are included in debt costs.

Sources: ABS; APRA; ASX; Bloomberg; LSEG; major bank liaison; major banks' websites; RBA; Securitisation System; US Federal Reserve.

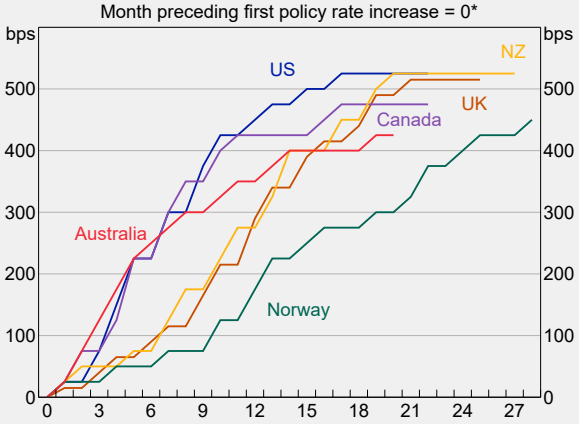
Box B: Comparison of pass-through to deposits in Australia relative to peer economies

Deposit rates across advanced economies have increased, consistent with increases in policy rates that tightened broader financial conditions (Graph B1). However, outstanding deposit rates in Australia have increased more quickly and by more than deposit rates in most other advanced economies, despite a relatively smaller increase in the policy rate in Australia (Graph B2; Kent 2023).

Graph B1

Change in Policy Rates

Month preceding first policy rate increase = 0*



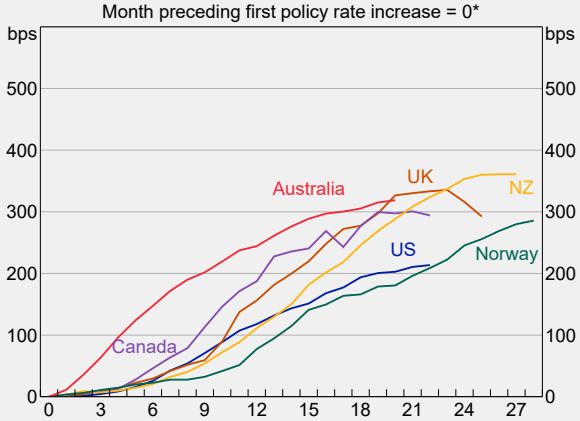
* Cumulative basis point increase in the policy rate relative to the month immediately preceding first policy rate increase since the onset of the pandemic.

Sources: Central banks; RBA.

Graph B2

Change in Outstanding Deposit Rates

Month preceding first policy rate increase = 0*



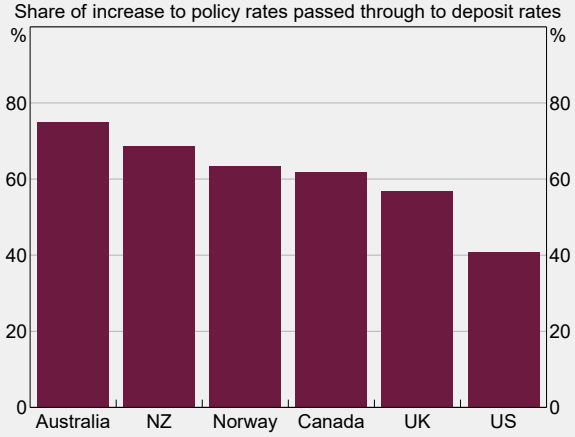
* Cumulative basis point increase in the average deposit rate relative to the month immediately preceeding first policy rate increase since the onset of the pandemic.

Sources: APRA; Central banks; RBA.

Deposit rates in Australia have also increased by more than peer economies after accounting for differences in the extent of monetary policy tightening. Around 75 per cent of the change in the cash rate has passed through to outstanding deposit rates in Australia, which is in line with the broad range of outcomes in previous hiking phases in Australia. This is higher than those of other advanced economies, where pass-through ranges from 40 to 70 per cent (Graph B3).

A range of institutional features of the Australian financial system are likely to explain the higher pass-through of cash rate changes to deposit rates. For example, Australian mortgage rates are sensitive to changes in the cash rate, reflecting the low share and shorter terms of fixed-rate mortgages in Australia. Australian banks therefore tend to fund these loans with deposits or from market sources that are ultimately linked to short-term rates such as BBSW. This means that the repricing structures of Australian bank mortgage and deposit books are similar, and changes in the cash rate have a relatively small effect on NIMs (Brassil, Cheshire and Muscatello 2018). In Australia, the lending spread has been relatively stable, although it has declined somewhat in this hiking phase.

Graph B3
Bank Deposit Pass-through*
Share of increase to policy rates passed through to deposit rates



* The cumulative change in average outstanding deposit rates divided by the cumulative change in policy rates from the start of each country's post-pandemic hiking phase until end-2023.

Sources: APRA; central banks; RBA.

Endnotes

[*] The authors are from Domestic Markets Department. They would like to thank Tekla Bastian, Sam Batchelor, Duke Cole, Sean Dowling, Oscar To and David Wakeling for their contributions.

[1] An offset account is an at-call deposit account that is directly linked to a mortgage loan and offsets the outstanding loan balance. As a result, offset accounts effectively receive the mortgage interest rate. We exclude offset accounts from our deposit rate calculations to avoid skewing the data. However, we include them in our calculation of banks' overall funding costs, given they represent a cost to banks.

[2] Banks allocate costs to different business units, such as mortgage lending, through funds transfer pricing. See ACCC (2023) for discussion on how funds transfer pricing works.

[3] Although the lending spread is the primary driver of banks' NIMs, the NIM also includes other interest-earning assets such as securities. The lending spread presented in this article includes the RBA's model estimate of hedging, which may differ from the actual costs of hedging faced by banks, captured in their NIMs.

[4] See, for example, the Commonwealth Bank's 2023 profit announcement (CBA 2023) and the National Australia Bank's 2023 annual report (NAB 2023).

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The Effect of Least-cost Routing on Merchant Payment Costs

Boston Dobie and Benjamin Watson[*]

Photo: Yana Iskayeva – Getty Images

Abstract

The RBA supports all merchants being able to choose the card network used to process debit transactions – a functionality known as least-cost routing (LCR) – with the aim of increasing competition and reducing the cost of accepting card payments. This article presents the RBA's first estimates of the effects of LCR on a merchant's cost of accepting debit card payments. Using merchant-level data, we estimate that the cost of accepting debit card transactions is nearly 20 per cent lower for merchants that have LCR turned on compared with those with LCR turned off, though the results differ across merchant size and choice of pricing plans. Once LCR for online and mobile wallet payments is widely available and taken up by merchants, the potential cost savings are likely to be even larger.

Introduction

Debit cards are the single most used payment method by Australians, accounting for half of the total number of consumer payments in 2022. Whenever a consumer uses their card to make a payment, the merchant is charged a fee. These fees vary and can add up to be a significant cost to the merchant and, ultimately, the consumer if those costs are passed on.

To help reduce the cost of accepting card payments, the RBA is encouraging greater uptake of least-cost routing (LCR) – a function that allows the merchant to choose which card network processes debit card transactions. This should create greater competition between the networks and lead to savings for both merchants and consumers.

This article aims to fill a gap by presenting the RBA's first modelled estimates of the effects of LCR on a merchant's cost of accepting debit card payments. First, it describes the current fee structure for debit card transactions, before explaining how LCR works to lower these fees for merchants by giving them greater choice. The article then describes the data and methodology used to conduct our research into determining the cost savings of LCR. It concludes with a discussion of the results and associated policy implications.

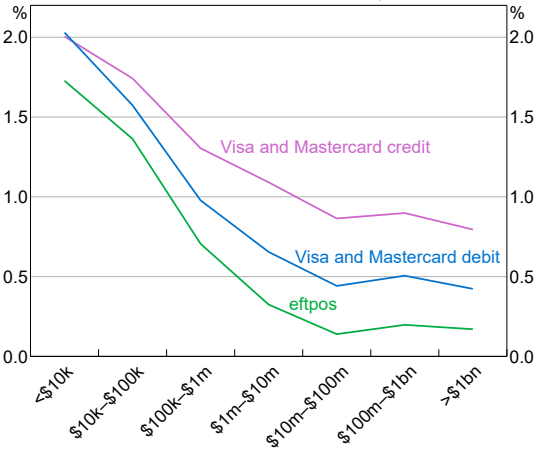
Current fee structure for card payments

The cost for a merchant to accept a card payment can vary widely, from below 0.2 per cent to over 2 per cent of the transaction value (Graph 1). This is the merchant's 'cost of acceptance', which refers to the percentage fee merchants pay to their payment service provider (PSP) for a card transaction.[1] These costs include both transaction-based fees and fixed fees.

Graph 1

Cost of Acceptance by Scheme*

Per cent of value of card transactions, 2022/23



* Weighted average. Cost of acceptance is inclusive of GST.

Source: RBA.

The transaction-based fees are made up of:

- **Interchange fees** – wholesale fees set by card networks (eftpos, Visa, Mastercard) that are paid from the merchant's PSP to the cardholder's financial institution (issuer) on every transaction. These fees can vary based on factors like the type of card, whether it is an online or in-person transaction, the value of the transaction and the size of the merchant. For example, cards that provide rewards to the cardholder (such as 'gold' or 'platinum' credit cards) have higher interchange fees.
- **Scheme fees** – wholesale fees payable separately by both PSPs and issuers to card networks for the services they provide (often charged on a per-transaction basis).
- **PSP margin** – additional fees levied on merchants by their PSP, including to cover the PSP's cost of providing card acceptance services to merchants.

Other fees include monthly or annual fees, terminal rental fees or joining fees.[2]

An individual merchant's cost of acceptance is influenced by a range of factors, with the main ones being:

- **Size**. Large merchants typically have lower costs of acceptance. Their greater bargaining power allows them to negotiate lower fees. They can also spread any fixed costs over more transactions.
- **Payments mix**. Card transactions incur different costs depending on whether they are debit or credit, whether they are in-person or online, and whether they are processed through eftpos or an international card network (Visa/Mastercard).
- **PSP**. Each provider can charge different rates and may offer a different package of services.
- **Pricing plan**. PSPs offer merchants 'fixed', 'blended' and 'unblended' pricing plans for their payment services (Table 1):
  - *Fixed plans* are simple plans that charge one single rate for all transactions.
  - *Blended plans* have some transaction types 'blended together' at one price, such as one rate for all Visa (debit and credit) transactions, one rate for all Mastercard (debit and credit) transactions, and a different rate for all eftpos transactions.
  - *Unblended plans* (also called 'interchange plus' or 'interchange plus plus' plans) are typically the cheapest (Graph 2). These plans charge merchants the wholesale cost of each transaction plus the PSP's margin,

Table 1: Examples of Pricing Plan Types and Related Costs of Acceptance[a]

	Fee charged by PSP Per cent				
Plan type	eftpos	Visa debit	Visa credit	Mastercard debit	Mastercard credit
Fixed	1.4	1.4	1.4	1.4	1.4
Blended[b]	0.4	1.1	1.1	1.1	1.1
Unblended	0.22	0.45	0.99	0.47	0.97

(a) These rates are indicative only.

(b) This example presents only one type of blended plan. Other blended plans are available with different rates blended together. For example, a separate Visa/Mastercard credit rate and Visa/Mastercard debit rate.

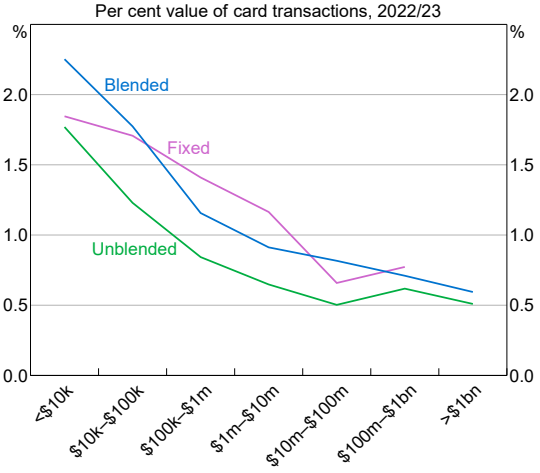
Source: RBA.

meaning merchants pay a different rate for each transaction, depending on factors such as the card type (e.g. credit or debit), transaction type (e.g. in-person or online) and card network (eftpos, Visa or Mastercard).

Graph 2

Cost of Acceptance by Pricing Plan*

Per cent value of card transactions, 2022/23



* Weighted average. Cost of acceptance is inclusive of GST.

Source: RBA.

A merchant's cost of acceptance for a specific payment is set by their PSP, but can vary depending on the card network (eftpos, Visa, Mastercard) that processes the transaction. Different card networks set different interchange fees and scheme fees that apply to the transactions they process, with these costs ultimately passed on to merchants by PSPs. PSPs may also add different margins on transactions of different networks. This means that the cost of a payment at any given merchant may be different depending on the network that processes it.

In Australia, domestically issued debit cards are typically 'dual-network' debit cards. These cards allow transactions to be processed through either eftpos or one of the international debit networks (most commonly Visa or Mastercard). Contactless card payments made with dual-network debit cards default to using the international debit network, due to rules set by the international networks. Payments processed through the international networks are more expensive on average, though this at least partially reflects compositional differences in the transactions processed by each network, as well as the pricing practices of PSPs (Graph 1). Since 95 per cent of in-person card payments were contactless in 2022, this means that most debit card payments route by default to the (typically) more expensive international network.

Least-cost routing

LCR allows merchants to choose how contactless debit payments are routed and thereby can directly reduce a merchant's payment costs. This functionality also increases competitive pressure between the debit networks, providing greater incentives for the networks to lower the wholesale fees that are ultimately paid by merchants.

There are two primary models for how LCR works in practice:[3]

1. **The binary model** – where all relevant transactions are routed to the merchant's (or PSP's) chosen network.
2. **The threshold model** – where payments are routed to eftpos if the transaction size is above a certain dollar value (because eftpos is usually priced in cents), with smaller payments routed to Visa or Mastercard (because they are usually priced in percentage terms).

Whether a merchant has LCR enabled depends on their own choices and the choices of their PSP – PSPs can either enable LCR for merchants or let merchants themselves decide whether to enable LCR. We would expect the level of knowledge that a merchant has about the costs of different card networks to affect their chosen routing preference.

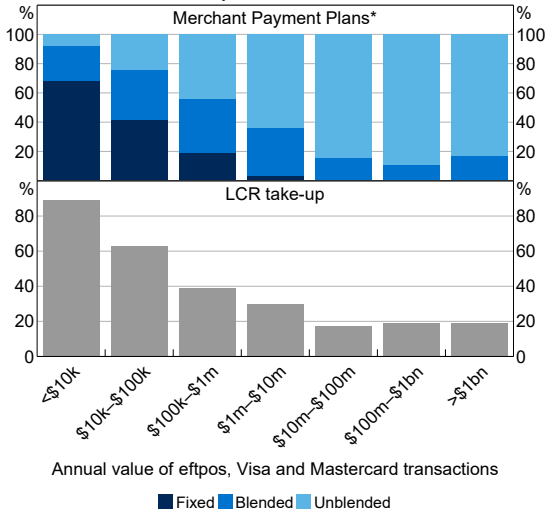
In 2022/23, just over a half of merchants had LCR enabled, despite LCR being available to approximately 99 per cent of merchants by June 2023 (RBA 2023).[4] Small merchants are more likely to have LCR turned on, particularly those with less than $1 million in annual card transactions (Graph 3). Higher take-up among smaller merchants may be due to their higher use of fixed pricing plans (which increasingly have LCR enabled automatically): 95 per cent of merchants with fixed plans in 2022/23 had LCR turned on, compared with just 54 per cent of merchants on blended plans and only 15 per cent on unblended plans (Graph 4).

The Reserve Bank's Payments System Board has responsibility for promoting the stability, efficiency and competitiveness of Australia's payments system. Given the high share of payments made using cards in Australia, the RBA views merchants' card payment costs as a key indicator of efficiency and competition in the payments system. Accordingly, the Board has strongly supported the continued issuance of dual-network debit cards and the provision of LCR functionality. The Board has taken action to encourage the availability and uptake of LCR by setting expectations that PSPs offer and promote LCR. This includes expectations to make LCR available for online and mobile wallet transactions, which is still being developed and rolled out.[5]

Graph 3

Merchant Payment Plans

By size, 2022/23



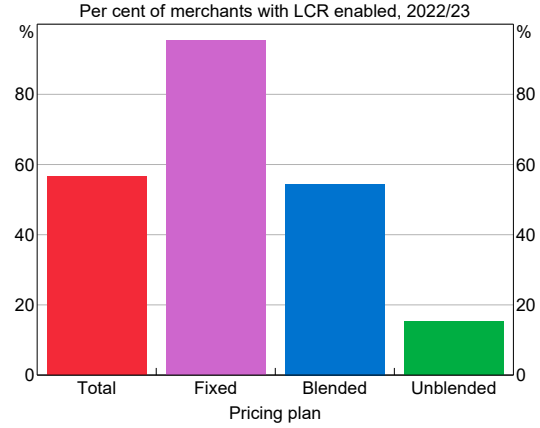
* A small number of merchants using 'other' pricing plans have been excluded from this graph.

Source: RBA.

Graph 4

LCR Take-up by Pricing Plan*

Per cent of merchants with LCR enabled, 2022/23



* Uses merchant level data collected by the RBA for 2022/23.

Source: RBA.

Measuring the effect of LCR on merchant costs

To support the Board's goal to encourage uptake of LCR, we conducted research on the benefits and cost savings of LCR to merchants.

Data and methodology

To investigate the relationship between LCR and merchant payment costs we used annual merchant-level data collected by the RBA for 2022/23, which included a flag for whether each merchant had LCR enabled. Our data are cross-sectional: we only observe merchants at a point in time. The 2022/23 data included 860,000 merchants and captured $630 billion worth of card transactions. The data provide anonymised information about each specific merchant, such as the number and value of transactions they processed in the year, their industry, their PSP, and the fees they paid to accept different types of card payments. The data also indicate whether a merchant was on a fixed, blended or unblended pricing plan. However, the data do not identify differences within these plan types, such as the specific rates blended together for different types of blended plans or the services included as a part of the pricing plans. The data also do not distinguish between in-person and online payments.

For our analysis, we used a subset of the data that excludes merchants with PSPs that do not offer both 'LCR-on' and 'LCR-off' plans. We also conducted some data cleaning to remove merchants with missing or implausible data.[6] The reduced sample includes eight PSPs and about 525,000 merchants, 29 per cent of which had LCR enabled. These data cover approximately two-thirds of the debit card market in Australia.

In 2022/23, LCR was primarily available in the in-person environment, with limited availability for online transactions and no availability for mobile wallet transactions. Therefore, our analysis is principally an analysis of the effect of in-person LCR on merchant payment costs. Given around 40 per cent of debit transactions are made via mobile wallets and around 25 per cent online, once LCR for these types of payments is available, the potential costs savings would be even larger.[7]

Simple analysis

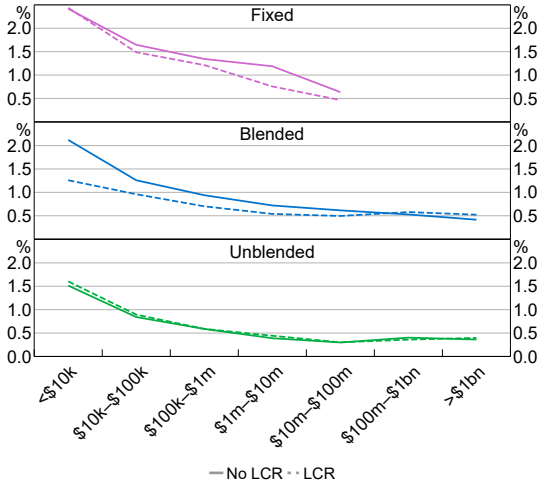
We found that in 2022/23 merchants with LCR turned on had a marginally *higher* cost of acceptance for debit cards on average than those with LCR turned off (0.56 per cent versus 0.52 per cent). This is counterintuitive because LCR is expected to reduce the cost of acceptance for merchants. However, this result likely reflects that LCR enablement is correlated with other merchant characteristics that affect the cost of acceptance. Indeed, we found that merchants with LCR were more likely to be small merchants, more likely to be on fixed plans, and more likely to be with certain PSPs that cost more on average. As such, these other merchant characteristics are likely to have pushed the average cost higher, rather than LCR being the driving factor.

The difference in the average cost of acceptance for merchants with and without LCR varied depending on the type of pricing plan a merchant had and the size of a merchant. Having LCR enabled was associated with a lower cost of acceptance for merchants of most sizes when they were on blended and fixed plans, although the cost difference varied by merchant size (Graph 5). There was minimal difference in the average cost of acceptance faced by merchants on unblended plans with and without LCR.

Graph 5

Debit Cost of Acceptance by Pricing Plan*

Per cent value of card transactions, 2022/23



* Weighted average. Cost of acceptance is inclusive of GST. Excludes payment service providers that do not offer both LCR-on and LCR-off plans.

Source: RBA.

It is difficult to draw strong conclusions about the impact of LCR on merchant costs from these simple comparisons. Merchants with and without LCR have different characteristics, which likely influence their costs of acceptance. The size of any 'LCR effect' may also depend on these various merchant-level characteristics. Accordingly, we used a more formal econometric analysis to account for these factors.

Regression analysis

Regression analysis allows us to compare the cost of acceptance of merchants with LCR-on and merchants with LCR-off, while holding their other characteristics constant. Our main model estimates the relationship between a merchants' cost of acceptance, their size (annual debit card transaction value), their pricing plan, their PSP, whether they can be considered a high-risk merchant, and whether they had LCR enabled.[8] The model specifications are described in Appendix A and the regression results are in Appendix B.

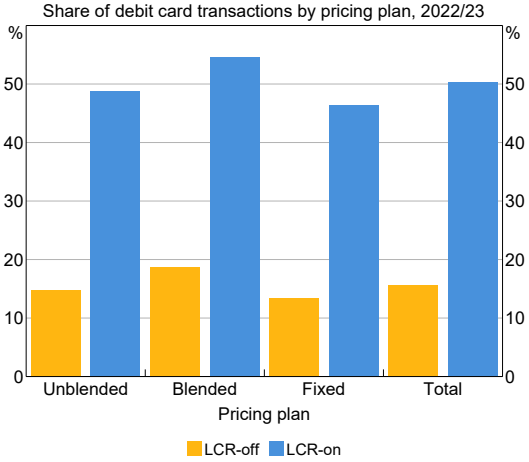
The nature of regression analysis means that we cannot necessarily imply causation for our results, but there are plausible causal channels. By having LCR enabled, more transactions should route via the lower-cost debit card network (generally eftpos), thereby reducing merchants' payment costs. There is evidence in the data that this causal channel is working. The share of transactions routed via eftpos is significantly higher for merchants with LCR enabled than for those without it enabled – for all pricing plans (Graph 6). On average, merchants with LCR enabled route 50 per cent of their debit card transactions through eftpos, compared with only 14 per cent for those without LCR enabled.

Our regression results would not be causal if merchants with LCR enabled had unobserved characteristics that are correlated with their payment costs. For example, merchants with LCR enabled could be more likely to have a higher share of in-person transactions, which typically cost less than online transactions. This higher share of in-person transactions may reduce their cost of acceptance, irrespective of LCR. Given the richness of our data, we think there are few characteristics not accounted for in our models that would materially affect merchants' cost of acceptance, but we cannot definitively rule out that possibility.

Graph 6

Transactions Routed via eftpos*

Share of debit card transactions by pricing plan, 2022/23



* A small number of merchants using 'other' pricing plans have been excluded from this graph. Merchants with payment service providers that do not offer both LCR-on and LCR-off plans were excluded.

Source: RBA.

Aggregate effect of LCR

Our results suggest that enabling LCR is associated with a lower cost of accepting debit card payments. On average, in 2022/23 merchants with LCR enabled were estimated to have a cost of acceptance that was 19 per cent lower than other similar merchants. This means that if a merchant without LCR enabled had a cost of acceptance of 1 per cent, our results imply that a similar merchant with LCR enabled would (on average) have a cost of acceptance of 0.81 per cent. In dollar terms, our result implies that the median-sized merchant, with about $110,000 in annual debit card transactions, would save around $310 per year from LCR. The average-sized merchant with $675,000 in annual debit card transactions would save around $1,150 per year (see Appendix C for calculations).

These results are consistent with our expectation that LCR should reduce merchant payment costs.

Table 2: Pass-through of LCR

By plan type

Pass-through	Unblended	Blended – separate eftpos rate	Blended – single debit rate	Fixed
PSP debit rate	Different debit rates for each transaction (separate eftpos/Visa/ Mastercard rates)	Multiple debit rates, including a separate eftpos debit rate	Uniform debit rate for eftpos/Visa/ Mastercard transactions	Uniform debit rate for all card transactions
Pass-through of LCR	Direct – transactions route to lowest cost rate (generally eftpos)	Direct – transactions route to lowest cost rate (generally eftpos)	Indirect – PSPs may pass through lower wholesale costs by lowering the uniform debit rate	Indirect – PSPs may pass through lower wholesale costs by lowering the uniform debit rate

Source: RBA.

Effect of LCR on merchants with different pricing plans

The effect of LCR on a merchant's cost of accepting debit card payments may differ depending on their chosen pricing plan (Table 2). This is because each plan type offers different levels of blending between network and card types, which influences how lower wholesale costs from LCR flow through to each merchant's payment costs. The pass-through is more direct for merchants on unblended plans, as the wholesale cost of each transaction is passed directly through to the merchant (plus the PSP's margin). For merchants on fixed and blended plans, the potential pass-through is less direct. Some merchants on blended plans have a single Visa/Mastercard rate for credit and debit card payments, and a separate eftpos rate. Many of these merchants could save money in the first instance if more of their debit card transactions attracted the typically cheaper eftpos rate. For merchants on fixed plans, and blended plans with a combined debit rate for eftpos/Visa/Mastercard, to get the full benefit from LCR, their PSP needs to pass on the wholesale cost savings by lowering the per-transaction rates of their plans.

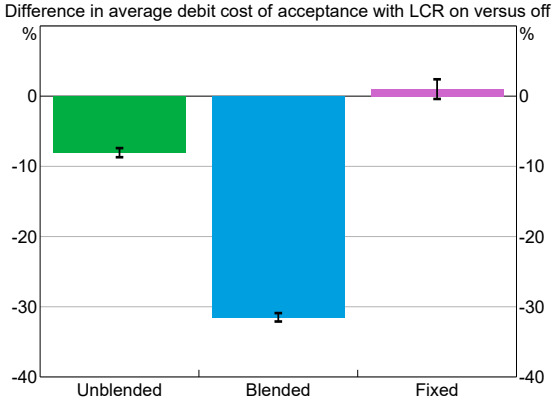
To investigate how LCR influences merchants' payment costs by pricing plan type, we extended the model to differentiate the impact of LCR depending on the chosen pricing plan (see Appendix A).

The results show that, for 2022/23, merchants with LCR enabled had lower costs of accepting debit card payments if they were on an unblended or blended plan, but not if they were on a fixed plan. On average, having LCR enabled was associated with an 8 per cent lower cost of acceptance for those on unblended plans and a 32 per cent lower cost of acceptance for those on blended plans (Graph 7). Having LCR enabled on a fixed plan did not appear to have a significant impact, on average, on a merchant's cost of acceptance. However, this varied depending on a merchant's PSP; merchants with three of the seven PSPs that offer fixed plans with and without LCR were estimated to have lower costs of acceptance from LCR.

Graph 7

Results by Pricing Plan*

Difference in average debit cost of acceptance with LCR on versus off



* Dashes represent 95 per cent confidence interval.

Source: RBA.

One potential reason that merchants on blended plans appear to be able to get larger savings from LCR is that the gap between the average eftpos rate and the average Visa/Mastercard debit rate is relatively large for these types of plans (Table 3). This gap may be high because, as noted above, some

Table 3: Average Debit Card Rates, 2022/23[(a)]

Per cent value of debit card transactions

Plan type	eftpos Per cent	Visa/Mastercard Per cent	Difference[(b)] Percentage points
Unblended – LCR on	0.25	0.61	0.36
Unblended – LCR off	0.20	0.42	0.22
Blended – LCR on	0.39	0.87	0.49
Blended – LCR off	0.35	0.89	0.54

(a) Excludes merchants that have not accepted both eftpos and Visa/Mastercard debit transactions within the year. Note: compositional differences account for some difference in the rates. Visa/Mastercard rates are more likely to include international and online transactions, which generally have higher wholesale costs.

(b) Differences are calculated using unrounded estimates.

Source: RBA.

blended rates for Visa and Mastercard also include more expensive credit card transactions. This means that as transactions route through eftpos due to LCR, the marginal saving on each transaction is higher for merchants on blended plans. Theoretically, the savings from LCR could be reduced if PSPs set their blended Visa/Mastercard rates on LCR plans higher to account for the fact that a larger proportion of their Visa/Mastercard transactions will be credit, rather than debit, due to more debit transactions being routed to eftpos. However, we found minimal evidence of this as the eftpos and Visa/Mastercard rates are relatively consistent between LCR-on and LCR-off merchants on blended plans on average (Table 3).

The lack of estimated cost savings from LCR for merchants on fixed plans is not what we expected. On the face of it, it suggests that at least some PSPs have not fully passed on the cost savings from LCR to merchants on fixed plans. However, we would caution against reading too much into this result for several reasons, including:

- In 2022/23, an overwhelming share of merchants on fixed plans had LCR enabled. The small number of LCR-off merchants may have had special characteristics that affected their cost of acceptance that the model cannot account for.
- Other services provided by PSPs beyond card transaction processing are increasingly being included in fixed plans, which may raise the cost of these plans (all else equal). Bundled services may be more common for LCR-on plans because they are 'newer', and the bundling of services has become more common in recent years, thereby making LCR-on plans look more expensive than LCR-off plans.
- PSPs may have to compete on the headline price of fixed plans, regardless of whether LCR is enabled, since LCR does not *directly* affect the merchant on these plans. This may lead to LCR-on and LCR-off fixed plans being similarly priced for a given level of bundled services.

In our dataset, we cannot observe the same merchants through time to see if the introduction of LCR has reduced the cost of their fixed plan, nor can we observe the differences in bundled services between different plans at the same PSP or across time. These limitations in our dataset make it difficult to draw strong conclusions about the effects of LCR for merchants on fixed plans.

Table 4: Merchant Size Buckets

2022/23

Size	Minimum annual debit card transactions	Maximum annual debit card transactions	Number of merchants
Micro	$0	$100,000	253,000
Small	$100,000	$1,000,000	223,000
Medium	$1,000,000	$10,000,000	46,000
Large	$10,000,000	–	3,400

Source: RBA.

Effect of LCR on merchants of different size

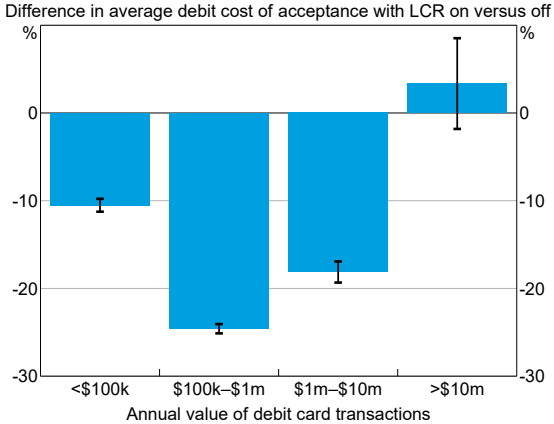
The descriptive statistics presented above suggest that the effect on merchants' costs of acceptance from having LCR enabled may vary depending on the size of a merchant. To investigate this, four versions of the model were estimated with samples based on merchant size. We divided the sample into four broad merchant size buckets based on annual debit card transaction values (Table 4).

The results of these regressions suggest that LCR-enabled merchants with between $100,000 and $10 million in annual debit card payments have lower payment costs than similar-sized merchants without LCR enabled (Graph 8). The smallest LCR-enabled merchants, with under $100,000 in annual debit card payments, are also estimated to have lower payment costs than similar-sized merchants without LCR, but to a lesser extent. The cost differences for LCR-enabled merchants are less clear for large merchants with over $10 million in annual debit card transactions.

Graph 8

Results by Merchant Size*

Difference in average debit cost of acceptance with LCR on versus off



* Dashes represent 95 per cent confidence interval.

Source: RBA.

It is not entirely clear why small merchants have higher suggested savings from LCR. It is not explained by the gap between the observed eftpos and international network rates, which are largely consistent by merchant size, or by a greater relative share of transactions having shifted to eftpos from the international networks, as this is also largely consistent by merchant size. Certain types of merchants – particularly very large merchants and those that the networks may consider to be 'strategic' – may qualify for lower interchange fees. This may explain the estimated limited impact of LCR for large merchants since their strategic Visa/Mastercard debit rates may be cheaper than their eftpos rate. If the difference in cost between eftpos and these strategic Visa/Mastercard rates are minimal, the potential savings from LCR would also be minimal.

Implications

The results presented in this analysis suggest that LCR reduces merchant payment costs on average. This supports the case for further LCR take-up by merchants and the rollout of LCR for online and mobile wallet transactions, which should further increase the cost savings from LCR. Our results imply that there is room for further reductions in payment costs through higher LCR take-up among merchants on unblended and blended plans; these merchants are estimated to save significantly from LCR, but have relatively low LCR uptake. Increased LCR take-up by smaller merchants, particularly those with under $10 million in annual debit card payments, could also reduce debit card payment costs.

Conclusion

This article introduces new estimates for the potential cost savings for merchants from enabling LCR. We estimate that on average LCR is associated with a nearly 20 per cent lower cost of acceptance for debit card transactions, with potential cost savings being largest for small merchants and those on plans that blend together prices for different card types. The results presented primarily capture the savings from LCR for in-person transactions using physical cards, given the limited availability of LCR for online and mobile wallet payments. As LCR becomes more readily available for these types of transactions, the potential savings should be higher given they account for a significant and growing share of debit card payments. Due to the nature of regression analysis, our results are not necessarily causal, but the evidence supporting the causal channel – by which LCR routes debit payments through the generally lower cost network (eftpos) – is consistent with our overall assessment that on average, LCR reduces merchant payment costs.

Appendix A: Regression specifications

We constructed regression models to formally assess the association between LCR and merchants' costs of acceptance. A log-log model was chosen for this analysis as it more accurately maps the non-linear relationship between cost of acceptance and merchant size. It also makes the results easy to interpret, because the coefficient on an explanatory variable can be interpreted as a percentage effect.

We run the following regression:

$$log\left(COA_i\right) = \beta_0[\log\left(SIZE_i\right)] + \beta_1[\log\left(SIZE_i\right) \times FIXED_i] + \beta_2[\log\left(SIZE_i\right) \times BLENDED_i]$$
$$+\beta_3[LCR_i] + \beta_4[FIXED_i] + \beta_5[BLENDED_i] + \beta_6[HIGHRISK_i] + \beta_7[HIGHRISK_i \times FIXED_i]$$
$$+\beta_8[HIGHRISK_i \times BLENDED_i] + \beta_{9to15}[PROVIDER2to8_i] + \beta_{16to22}[PROVIDER2to8_i \times FIXED_i]$$
$$+\beta_{23to29}[PROVIDER2to8_i \times BLENDED_i] + Constant + \varepsilon_i$$

where:

- COA_i – cost of acceptance for the i^{th} merchant's debit card transactions.

Explanatory variables for the i^{th} merchant:

- $SIZE_i$ – a merchant's size based on annual debit card transaction value (representing merchant size)
- LCR_i – indicator variable equal to 1 if a merchant has LCR enabled
- $FIXED_i$ – indicator variable equal to 1 if a merchant has a fixed pricing plan
- $BLENDED_i$ – indicator variable equal to 1 if a merchant has a blended pricing plan
- $HIGH\ RISK_i$ – indicator variable equal to 1 if a merchant is in a high-risk industry
- *PROVIDER* – several indicator variables for each PSP in the sample.

Interaction terms:

- log(*SIZE*) × $FIXED_i$ – to capture the additional impact of merchant size on merchants with fixed plans
- log(*SIZE*) × $BLENDED_i$ – to capture the additional impact of merchant size on merchants with blended plans
- *HIGH RISK* × $FIXED_i$ – to capture the additional impact of a merchant being high risk when on a fixed plan
- *HIGH RISK* × $BLENDED_i$ – to capture the additional impact of a merchant being high risk when on a blended plan
- *PROVIDER* × $FIXED_i$ – to capture the additional impact of a merchant with a specific PSP when on a fixed plan

- *PROVIDER* × *BLENDED*$_i$ – to capture the additional impact of a merchant with a specific PSP when on a blended plan.

For each indicator variable with more than two possible outcomes, one dummy must be excluded to prevent perfect multicollinearity. For the pricing plan indicators, the unblended pricing plan was excluded. A specific PSP was also excluded (Provider 1 for simplicity). As a result, the base merchant was on an unblended plan with the excluded PSP.

The listed explanatory variables were chosen as we expected that they each would affect a merchant's cost of acceptance. Each explanatory variable was also interacted with each pricing plan indicator variable. This was done to account for our assumptions that:

1. the relationship between merchant size and cost of acceptance is heterogenous between pricing plans
2. a merchant being considered high risk has a different impact on their cost of acceptance depending on their pricing plan
3. the difference in average cost of acceptance for merchants with each PSP from the base PSP differs by pricing plan.

By controlling for these variables, the model should draw out the effect of LCR abstracting from these other influences on the cost of acceptance.

We also extended the model to identify whether LCR influences merchants' costs of acceptance differently depending on what pricing plan they use:

$$log\left(COA_i\right) = \beta_0[\log\left(SIZE_i\right)] + \beta_1[\log\left(SIZE_i\right) \times FIXED_i] + \beta_2[\log\left(SIZE_i\right) \times BLENDED_i]$$
$$+\beta_3[LCR_i] + \beta_4[FIXED_i] + \beta_5[BLENDED_i] + \beta_6[HIGHRISK_i] + \beta_7[HIGHRISK_i \times FIXED_i]$$
$$+\beta_8[HIGHRISK_i \times BLENDED_i] + \beta_{9to15}[PROVIDER2to8_i] + \beta_{16to22}[PROVIDER2to8_i \times FIXED_i]$$
$$+\beta_{23to29}[PROVIDER2to8_i \times BLENDED_i] + \beta_{30}[LCR_i \times FIXED_i] + \beta_{31}[LCR_i \times BLENDED_i] + Constant + \varepsilon_i$$

This specification was identical to the base model but with two additional interaction terms:

- *LCR* × *FIXED* – to capture the additional impact of LCR on merchants with fixed plans
- *LCR* × *BLENDED* – to capture the additional impact of LCR on merchants with blended plans.

Appendix B: Regression results

Table B1: Regression Results[(a)]

Regression outputs – 2022/23

Variable	Base Log(COA)	By pricing plan Log(COA)	Size 1 Log(COA)	Size 2 Log(COA)	Size 3 Log(COA)	Size 4 Log(COA)
Log(SIZE)	−0.17***	−0.17***	−0.16***	−0.13***	−0.25***	0.04***
	(0.000528)	(0.000529)	(0.001328)	(0.00204)	(0.004783)	(0.012113)
Log(SIZE) × FIXED	0.03***	0.04***	0.02***	0.05***	−0.10**	−0.14
	(0.001293)	(0.001292)	(0.002432)	0.0056)	(0.033628)	(0.296324)
Log(SIZE) × BLENDED	0.02***	0.02***	−0.01***	0.03***	0.11***	−0.02
	(0.000888)	(0.00089)	(0.002186)	(0.003217)	(0.009504)	(0.034316)
LCR	−0.19***	−0.08***	−0.11***	−0.25***	−0.18***	0.03
	(0.002181)	(0.003434)	(0.003747)	(0.002698)	(0.006145)	(0.02638)
FIXED	0.50***	0.26***	0.49***	0.43***	2.05***	3.20
	(0.014655)	(0.016313)	(0.025146)	(0.068805)	(0.490886)	(4.879848)
BLENDED	0.05***	−0.004	0.33***	−0.18***	−1.22***	1.30*
	(0.012471)	(0.012471)	(0.024196)	(0.04188)	(0.139624)	(0.575068)
HIGH RISK	0.04***	0.04***	0.12***	−0.03***	−0.08***	0.002
	(0.003452)	(0.003442)	(0.005611)	(0.00463)	(0.008792)	(0.034492)
HIGH RISK × FIXED	−0.03***	−0.03***	−0.09***	−0.01	0.12***	N/A
	(0.008266)	(0.008239)	(0.010705)	(0.014721)	(0.093745)	
HIGH RISK × BLENDED	−0.01·	−0.01·	0.03**	0.01	−0.02***	0.14***
	(0.006277)	(0.006256)	(0.009792)	(0.00845)	(0.018266)	(0.119091)
PAYMENT SERVICE PROVIDER 2	−0.07***	−0.07***	−0.21***	0.02***	0.06***	0.56***
	(0.00238)	(0.002373)	(0.003858)	(0.003027)	(0.007413)	(0.030011)
PAYMENT SERVICE PROVIDER 3	0.36***	0.26***	−0.17***	0.52***	0.61***	1.32***
	(0.005114)	(0.005638)	(0.011051)	(0.005872)	(0.011794)	(0.093553)
PAYMENT SERVICE PROVIDER 4	−0.14***	−0.17***	−0.34***	0.08***	0.32***	1.19***
	(0.004216)	(0.00424)	(0.005759)	(0.006794)	(0.017203)	(0.056349)
PAYMENT SERVICE PROVIDER 5	0.69***	0.68***	0.10	0.62***	0.88***	1.31***
	(0.022393)	(0.022319)	(0.060776)	(0.037247)	(0.037918)	(0.048266)
PAYMENT SERVICE PROVIDER 6	0.05***	0.13***	0.11***	0.09***	−0.14***	−0.75***
	(0.007915)	(0.007994)	(0.013196)	(0.010769)	(0.021264)	(0.132727)
PAYMENT SERVICE PROVIDER 7	−0.23***	−0.24***	0.08***	−0.32***	−0.22***	0.11***
	(0.004201)	(0.004194)	(0.009375)	(0.005433)	(0.008027)	(0.024707)
PAYMENT SERVICE PROVIDER 8	0.20***	0.17***	0.13***	0.21***	0.35***	0.96***
	(0.003555)	(0.003613)	(0.005824)	(0.004492)	(0.010763)	(0.035131)
PAYMENT SERVICE PROVIDER 2 × FIXED	0.06***	0.08***	0.20***	−0.05***	0.29***	N/A
	(0.005801)	(0.005835)	(0.007903)	(0.008774)	(0.055483)	
PAYMENT SERVICE PROVIDER 3 × FIXED	−0.35***	−0.19***	0.14***	−0.43***	0.01	−0.86
	(0.007509)	(0.00793)	(0.013241)	(0.010653)	(0.044984)	(0.542545)
PAYMENT SERVICE PROVIDER 4 × FIXED	0.21***	0.36***	0.32***	−0.02	0.38***	−0.87*
	(0.014202)	(0.01473)	(0.024625)	(0.017264)	(0.055766)	(0.365052)
PAYMENT SERVICE PROVIDER 5 × FIXED	−0.56***	−0.50***	−0.14	−0.18	N/A	N/A
	(0.127519)	(0.12711)	(0.171758)	(0.223167)		

Variable	Base Log(COA)	By pricing plan Log(COA)	Size 1 Log(COA)	Size 2 Log(COA)	Size 3 Log(COA)	Size 4 Log(COA)
PAYMENT SERVICE PROVIDER 6 × FIXED	−0.79***	−0.86***	−0.92***	−0.71*	−0.18	N/A
	(0.0186)	(0.01858)	(0.02598)	(0.027773)	(0.096974)	
PAYMENT SERVICE PROVIDER 7 × FIXED	−0.18***	0.002	−0.66***	−0.03	0.20**	N/A
	(0.02588)	(0.026404)	(0.050274)	(0.029227)	(0.078334)	
PAYMENT SERVICE PROVIDER 8 × FIXED	0.49***	−0.03**	−0.06***	−0.30***	−0.05	N/A
	(0.007384)	(0.009162)	(0.010785)	(0.010171)	(0.06656)	
PAYMENT SERVICE PROVIDER 2 × BLENDED	−0.02**	−0.01	0.02	0.01	−0.25***	−0.67
	(0.008051)	(0.008029)	(0.012546)	(0.011725)	(0.0204)	(0.088172)
PAYMENT SERVICE PROVIDER 3 × BLENDED	−0.17***	−0.03***	0.02	−0.07***	−0.002	−0.57**
	(0.008393)	(0.008904)	(0.015425)	(0.011222)	(0.01955)	(0.190699)
PAYMENT SERVICE PROVIDER 4 × BLENDED	0.51***	0.55***	0.68***	0.31***	0.16***	−0.11
	(0.010486)	(0.010476)	(0.016921)	(0.01429)	(0.033916)	(0.150019)
PAYMENT SERVICE PROVIDER 5 × BLENDED	−0.65***	−0.62***	−0.58***	−0.34***	−0.58**	−0.78**
	(0.095821)	(0.095504)	(0.160966)	(0.170678)	(0.225724)	(0.245962)
PAYMENT SERVICE PROVIDER 6 × BLENDED	N/A	N/A	N/A	N/A	N/A	N/A
PAYMENT SERVICE PROVIDER 7 × BLENDED	0.49***	0.51	0.15***	0.60***	0.50***	0.08
	(0.007925)	(0.007916)	(0.014386)	(0.011069)	(0.017477)	(0.081719)
PAYMENT SERVICE PROVIDER 8 × BLENDED	0.07***	0.15***	0.12***	0.10***	−0.01	−0.30***
	(0.008096)	(0.008217)	(0.013199)	(0.011146)	(0.020962)	(0.088843)
LCR × FIXED	–	0.09***	–	–	–	–
		(0.007741)				
LCR × BLENDED	–	−0.23***	–	–	–	–
		(0.004607)				
Constant	1.57***	1.59***	1.54***	1.01***	2.68***	−2.59***
	(0.006495)	(0.006492)	(0.013629)	(0.025865)	(0.069495)	(0.204332)
Observations	525,770	525,770	253,146	223,008	46,266	3,350
Adjusted R^2	0.45	0.45	0.31	0.37	0.38	0.49

(a) ' ' if p<1, '·' if p<0.1 '*' if p<0.05, '**' if p<0.01, '***' if p<0.001. Standard errors are reported in brackets.

Source: RBA.

Appendix C: Merchant savings from LCR

Table C1: Data for Savings Calculation

Savings	Mean (average) merchant	Median merchant
Annual debit card transactions	$676,723	$109,285
Cost of acceptance	0.90%	1.51%
Estimated percentage savings from LCR	19%	19%
Savings from LCR	$1,154	$313

Source: RBA.

Calculation formulas:*

$$Current\ Merchant\ Fees = Annual\ debit\ transactions \times Cost\ of\ Acceptance$$

$$Reduced\ Cost\ of\ Acceptance = Cost\ of\ Acceptance \times (1 - Estimated\ percentage\ Savings\ from\ LCR)$$

$$Reduced\ Merchant\ Fees = Annual\ debit\ transactions \times Reduced\ Cost\ of\ Acceptance$$

$$Annual\ dollar\ savings\ from\ LCR = Current\ Merchant\ Fees - Reduced\ Merchant\ Fees$$

Mean merchant example:*

$$Current\ Merchant\ Fees = \$676{,}723 \times 0.0090 = \$6{,}073$$

$$Reduced\ Cost\ of\ Acceptance = 0.90\% \times (1 - 0.19) = 0.73\%$$

$$Reduced\ Merchant\ Fees = \$676{,}723 \times 0.0073 = \$4{,}919$$

$$Annual\ dollar\ savings\ from\ LCR = \$6{,}073 - \$4{,}919 = \$1{,}154$$

* Figures are calculated using unrounded numbers.

Endnotes

[*] The authors are from Payments Policy Department. They would like to thank Troy Gill, Nicholas Prokhovnik, Robert Gao and Anirudh Yadav for their contributions in preparing this article.

[1] A 'payment service provider' is an organisation that provides card acceptance services to merchants, such as acquirers and payment facilitators. Examples include banks and fintechs.

[2] For more background, see Gill, Holland and Wiley 2022.

[3] A third version of LCR known as dynamic routing is offered by some PSPs, but with limited availability. Dynamic routing assesses the cost of routing to different networks for each individual transaction and then routes to the lowest cost network.

[4] The RBA receives LCR reporting data from acquirers on LCR availability and take-up every six months to monitor progress on the Board's LCR expectations.

[5] For further information, see Connolly (2023).

[6] Inactive merchants, identified as those with less than 20 transactions or with zero transaction value for the year, were excluded. We also removed the 2 per cent of merchants with an implausible cost of acceptance, such as a cost of acceptance above 100 per cent or below zero per cent. Merchants with missing data for their LCR status and pricing plan were also excluded.

[7] Mobile wallet and online transactions are not mutually exclusive. For example, some mobile wallet transactions are also online transactions.

[8] A merchant is considered high risk if they are in an industry that has a high rate of fraud and/or refunds. We also ran regressions controlling for merchant industry that gave broadly consistent results. Results are available on request.

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Gill T, C Holland and G Wiley (2022), 'The Cost of Card Payments for Merchants', RBA *Bulletin*, September.

RBA (Reserve Bank of Australia) (2023), 'Update on Availability and Enablement of Least-cost Routing for Merchants', August.

Financial Stability Risks from Non-bank Financial Intermediation in Australia

Marcus Robinson and Stefano Tornielli di Crestvolant[*]

Photo: Prasit photo – Getty Images

Abstract

Risks to financial stability posed by the non-bank financial intermediation (NBFI) sector in Australia remain relatively contained. In comparison to overseas, the size of the NBFI sector (excluding superannuation) is relatively small, and its interconnectedness with the traditional banking sector has continued to decline. However, as has been shown in recent periods of stress in overseas markets, vulnerabilities in the NBFI sector can have implications for financial stability. In particular, there remains a risk of disorderly movements in some international asset markets, which could be exacerbated by the role of overseas NBFIs and spill over into Australian markets. Lending by Australian non-banks remains small as a share of outstanding credit, but has recently shifted towards riskier market segments and there is less detailed information about this lending than that done by prudentially regulated banks. As part of its monitoring of evolving risks in the NBFI sector, Australia's Council of Financial Regulators has sought to improve visibility over domestic NBFIs' activities, including in commercial real estate and the growing use of over-the-counter derivatives. This article provides an analysis of recent developments and evolving risks posed by NBFIs in Australia.

Introduction

Non-bank financial intermediation firms, or NBFIs, provide financial services but do not hold a banking licence. They complement or provide competition to banks by offering a wide range of important and often highly specialised financial services, including managing investments (in the case of superannuation funds, investment funds and insurers), credit intermediation (in the case of non-bank lenders), facilitating financial market trading (in the case of market-makers and prime brokers) and providing services that are critical to the smooth functioning of financial markets (such as central counterparties).[1]

NBFIs can pose risks to financial stability due to their size, complexity and interconnectedness with the domestic and global financial systems. Some NBFI activities can also involve considerable use of leverage or give rise to liquidity mismatches, where investor redemptions in stressed market conditions have the potential to amplify volatility and result in fire sales of underlying assets (particularly in fixed income and real estate markets). While non-bank lending can have an important role in providing certain borrowers with access to financing, it tends to be more concentrated, pro-cyclical and risky than bank lending, partly reflecting less onerous regulatory obligations as these institutions cannot accept deposits for funding. This, in turn, can amplify credit and asset price cycles, and put pressure on banks to weaken their lending standards. Through interconnections with the banking system, stresses in the non-bank sector can also spread to banks, as was observed internationally during the global financial crisis (GFC).

In recent years, a number of vulnerabilities in NBFIs in advanced economies have crystallised and contributed to periods of market dysfunction. Hidden leverage and liquidity mismatches have amplified shocks and propagated strains through the financial system. This includes the dysfunction in the US Treasury market caused by the 'dash for cash' in March 2020; the Archegos collapse that caused material losses for prime brokers in 2021; the liquidity stress and resulting dysfunction in commodities markets in 2022; and the volatility in the UK gilt market emanating from UK pension funds in late 2022 (Choudhary, Mathur and Wallis 2023). Australia's financial system was largely resilient in those episodes. However, there remains a risk of disorderly movements in overseas asset markets, which could be exacerbated by NBFIs' activities and spill over into Australian markets.

The Council of Financial Regulators (CFR) monitors developments in the NBFI sector and considers any associated systemic risks for the Australian financial system. The analysis in this article was provided to the CFR ahead of its extended annual discussion of these issues at the December 2023 CFR meeting. Given the central role of the NBFI sector in recent global episodes of market volatility, the analysis includes a deep dive on the use of over-the-counter (OTC) derivatives by NBFIs in Australia. The analysis also covers NBFIs' activities in relation to commercial real estate (CRE) given the challenging conditions in this sector globally.

Size and interconnectedness of NBFI activities

Australia's NBFI sector is broadly comparable in size to other advanced economies at almost half of domestic financial assets. However, superannuation funds account for around half of NBFI assets in Australia, compared with around one-fifth in other advanced economies. Moreover, Australian superannuation funds are predominantly prudentially regulated defined contribution funds (i.e. investment risk is passed through to the fund members) and are constrained in their ability to take on leverage. Superannuation funds therefore pose fewer direct risks to financial stability (compared with other jurisdictions) as they play a small role in credit intermediation, have a preference for longer dated assets, enjoy stable funding and maintain large cash holdings (Choudhary, Mathur and Wallis 2023).

In contrast, the activities of those NBFIs that operate with higher leverage, or hold assets that are less liquid and longer dated than their liabilities (and are therefore more prone to liquidity and maturity risk), are considered more likely to present systemic vulnerabilities. The Financial Stability Board's (FSB) 'narrow' measure of NBFIs captures entities assessed

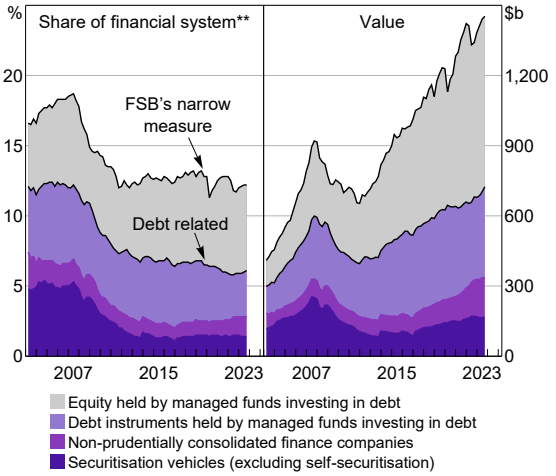
as being involved in credit intermediation activities that may pose 'bank-like' financial stability risks (e.g. liquidity/maturity transformation, leverage or imperfect credit risk transfer) and/or regulatory arbitrage (FSB 2023c). In Australia, this includes non-bank lenders such as finance companies, securitisation vehicles and managed funds investing in credit products. These NBFIs' assets were around 12 per cent of financial system assets in Australia in mid-2023, which is a little below pre-pandemic levels and well below the peak of 19 per cent reached prior to the GFC (Graph 1). Securitisation vehicles have accounted for much of this decline in the post-GFC era.

The interconnectedness of riskier NBFI activities with banks and the broader financial system through funding and credit channels has also declined over the past 15 years to around historical lows (Graph 2). A large share of the financial system's exposures to NBFIs is accounted for by the equity exposures of superannuation funds that are outsourced to (third-party) investment managers. Compared with other types of funding vehicles, including those for short-term debt funding, these types of arrangements have fewer direct implications for financial stability.

Graph 1

Non-bank Financial Intermediation

Financial assets*



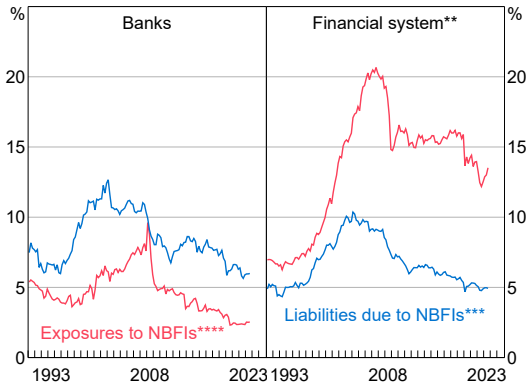
* Total assets where financial assets data are unavailable.
** Financial system excludes the RBA.

Sources: ABS; APRA; ASIC; RBA.

Graph 2

NBFI Interconnectedness*

Share of financial assets



* The definition of NBFIs in this chart excludes superannuation funds and insurers.
** Excludes the RBA.
*** Includes equity funding.
**** Excludes self-securitisation.

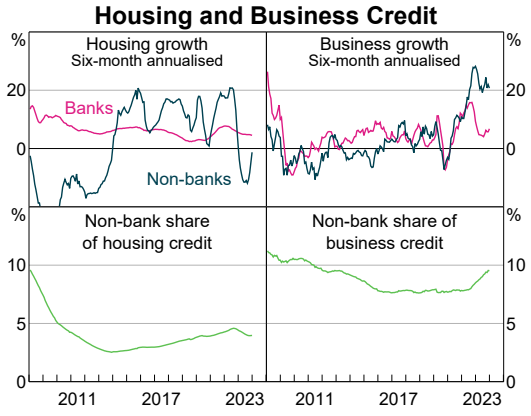
Sources: ABS; APRA; RBA.

Shifts in Australian non-bank lending

Rapid growth in Australian non-bank housing credit in the years prior to and during the COVID-19 pandemic had seen it increase to be a little less than 5 per cent of total housing credit, before this trend reversed in 2023 (Graph 3). The reversal largely reflected the increase in interest rates having a larger impact on the funding costs of non-banks compared with banks that benefit from (low- and non-interest-bearing) deposit funding. Weaker demand for non-investment grade residential mortgage-backed securities (RMBS) over 2022 and the first half of 2023 also led to an increase in funding costs for non-bank lenders. Heightened competition from large banks, particularly for higher quality non-bank borrowers, also weighed on growth in non-bank housing credit.

Graph 3

Housing and Business Credit



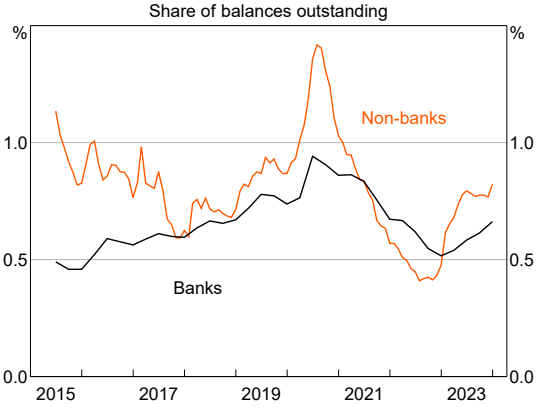
Sources: APRA; RBA.

Non-bank mortgage arrears tend to be higher than bank arrears and have risen more sharply over the past year than for banks (Graph 4). In part, this is because a higher proportion of non-bank lending is to borrowers who are more sensitive to economic conditions (e.g. self-employed workers). Non-bank lenders also lend predominantly on variable-rate terms, and so serviceability pressures will pass through their loan books more quickly than for banks who have a higher share of fixed-rate borrowers. Competition from large banks has also seen non-banks lose some high-quality borrowers who refinanced with banks on more favourable terms.

Graph 4

Housing Loans in 90-day Arrears*

Share of balances outstanding



* Latest observation is December 2023. Data on non-banks from Securitisation System; prudential collections for banks.

Sources: APRA; RBA; Securitisation System.

The RBA's liaison with non-bank lenders suggests some non-banks have relaxed underwriting and serviceability assessment standards for new loans. For instance, some non-bank lenders reduced their serviceability assessment buffer from 3 per cent to 2 or 1 per cent for refinancings on similar loan terms (i.e. no increase in total debt exposure) or loans assessed to have low credit risk.

Information from liaison also suggests some non-bank lenders have increased their share of new lending to some higher risk mortgage borrowers over 2023 (e.g. self-managed superannuation funds (SMSFs), low-doc, interest-only and investor loans). However, there are important mitigants that prevent systemic risks from non-banks' mortgage lending. Loan warehouse limits for securitisations and RMBS reporting requirements enforce discipline on loan quality. Furthermore, non-banks account for around half the share of total housing credit that they had during the GFC (Graph 3).

Non-banks have also increased their lending to businesses over recent years, with non-bank business credit growth elevated both historically and relative to banks (Graph 3). Non-banks' increase in business lending has been broad-based and encompasses forms of lending that banks have recently pulled back from such as property and construction lending. Non-banks have also increased some other higher risk forms of business lending, including auto loans, and lending to SMSFs. Unlike mortgage lending, only a very small share of non-banks' business loans are securitised and subject to warehousing limits on lending standards. As a result, loan quality is less transparent, making it more difficult to monitor the build-up of risks.

Qualitative evidence from the RBA's liaison program has highlighted instances of looser lending standards such as lending at higher loan-to-valuations and lower interest-coverage ratios. However, this is consistent with non-banks targeting certain segments of the market that are less attractive for banks, with the additional risk typically priced into lending rates. The Australian Prudential Regulation Authority (APRA) has reserve powers available to increase oversight if risks posed are deemed to be material. However, systemic risks posed by non-bank business lenders are currently limited by their size; these lenders account for only 9 per cent of total business lending in Australia.

NBFI risks in Australian commercial real estate

Conditions in CRE markets globally have deteriorated, with declines in rental income and asset valuations as a result of weaker tenant demand and higher interest rates. The deterioration has been particularly acute for lower grade offices. However, at this stage, there have been few signs of stress among owners of (or lenders to) CRE in Australia, although there is limited information on some owners (RBA 2024). While Australian banks' exposures to CRE are relatively low, historical downturns in CRE, such as during the GFC and the early 1990s recession, have illustrated that NBFIs in the CRE market can have significant negative effects

on the stability of the financial system due to their connection to the banking sector and role in amplifying credit and CRE price cycles. To identify areas of potential build-up in systemic risk from NBFI activity in the Australian CRE market, the size, vulnerabilities and interlinkages of NBFIs with domestic banks and foreign markets are examined below. The role of NBFI lenders and owners in CRE is discussed separately as they propagate financial stability risks through different channels.

Non-bank lenders

Non-bank lenders typically service segments of the CRE market where banks are constrained by regulation or risk appetite. While this lending activity can help to complete markets, it can also give rise to financial stability risks if it is associated with higher leverage, weaker underwriting standards and if lenders have concentrated asset holdings and funding sources. NBFI lenders include registered financial corporations (RFCs) and private sources of credit (i.e. debt funds). The RBA estimates that they account for less than one-fifth of direct CRE lending in Australia, with banks accounting for the rest.[2] Given the size of their CRE lending and limited borrowings from the banking system, these NBFIs do not appear to pose systemic risks in Australia.

NBFI owners

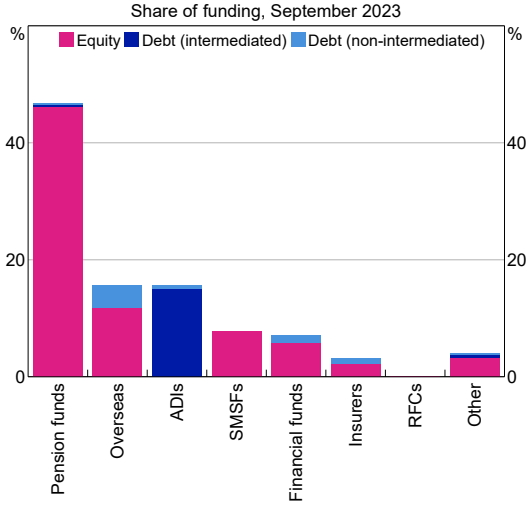
CRE owners can amplify credit and asset price cycles, and liquidity strains in times of stress. An estimate of the aggregate value of CRE assets in Australia is not readily available, though the relative ownership shares can be estimated for some asset classes by owner type, including unlisted trusts, listed Australian Real Estate Investment Trusts (A-REITs), foreign and domestic pension funds, non-financial corporations, sovereign funds and private investors. For example, it is estimated that unlisted trusts and foreign listed trusts are the largest owners of office assets (over one-third of outstanding stock), while a small number of listed A-REITs own around 60 per cent of retail space in Australia (Lim *et al* 2023).

The balance sheets of these participants are particularly important to assess as leverage and liquidity mismatches can transmit or amplify shocks in the CRE market (Graph 5).[3] For example, open-ended unlisted property trusts have exacerbated asset price declines in prior downturns, both domestically and abroad. However, most retail funds now have limits on redemptions (which can reduce the risk of asset fire sales in disorderly market conditions), and unlisted property trusts in aggregate appear to have relatively low leverage and stable equity funding.[4] The A-REIT sector has also reduced leverage since the GFC.

Graph 5

Property Trusts' Funding Sources*

Share of funding, September 2023



* Consolidated liabilities of listed and unlisted REITs, property common funds and infrastructure funds.

Sources: ABS; RBA.

Key NBFI-related vulnerabilities

In the context of a severe global and domestic downturn in CRE, NBFI-related vulnerabilities that could crystallise in the Australian financial system include the following:

- Unlisted property trusts that have high levels of leverage could amplify stress in CRE markets by engaging in asset fire sales. In aggregate, unlisted property trusts are estimated to have leverage of less than 25 per cent and source over 75 per cent of their equity funding from large superannuation funds with long-term investment mandates.[5] This aggregate combines a range of different leverage and funding profiles. The RBA's liaison has highlighted some instances of unlisted property trusts operating with high levels of leverage that could be problematic at the time of refinancing. However, information on the distribution and

size of highly leveraged unlisted funds is not available.

- SMSFs with concentrated investments in CRE assets and high leverage could also contribute to procyclicality in CRE markets. SMSFs hold a material share of CRE assets, either directly or through property trusts (Graph 5). Funds that are leveraged and highly concentrated in CRE assets could amplify stress by abruptly shifting assets out of the CRE sector in a downturn.
- As conditions in global CRE markets continue to deteriorate, there is a risk that stress in overseas CRE markets could spill over to Australian market conditions. For example, foreign bank lenders have exposure to the Australian CRE market, and a material share of CRE assets is owned by foreign investors (either directly or through pension funds), with one-third of Australian office assets estimated to be foreign-owned. Foreign owners also account for a material share of property trusts' funding (Graph 5). Domestic banks, who provide most of the intermediated debt funding for domestic CRE assets, could be exposed to credit losses if overseas stresses spill over to the domestic CRE market.
- Listed A-REITs' reliance on market-issued debt, including from overseas, could create some refinancing challenges. A-REITs are funded predominantly through non-intermediated debt, around half of which is from the United States and other offshore markets. If these offshore investors experience losses or liquidity shortfalls due to stresses in foreign CRE markets, they could withdraw or severely restrict their funding of A-REITs; this, in turn, could lead to forced asset sales. However, A-REITs are well placed to absorb refinancing risks for the time being, with less than one-fifth of funding due to mature over the next two years.

More generally, synchronised distressed sales of CRE assets in the Australian market, whether through abrupt portfolio shifts or forced deleveraging, could threaten the viability of some NBFIs and spill over into the real economy through developers and other non-financial participants.

Based on the available information, the RBA assesses that these vulnerabilities in the CRE market are unlikely to pose risks to financial stability, particularly due to the relatively small linkages between NBFIs and the core banking system. However, the significant data gaps surrounding the activities of NBFIs in the Australian CRE market are prompting close ongoing monitoring by the RBA and CFR.

Data gaps

Information is limited for many unlisted participants, including property trusts, developers and property companies.[6] In particular, the distribution of exposures and leverage within the less-transparent NBFI models (e.g. unlisted trusts) and non-financial participants is opaque.

Data on non-bank CRE lenders are also incomplete. Some RFC lenders in CRE do not report their holdings (e.g. due to being below size thresholds for APRA reporting). Other private credit lenders (i.e. debt funds) are not captured in regulatory reporting. Non-bank lenders also do not currently report on CRE lending quality. Given a small share of NBFI CRE lending is securitised, insights on lending quality in the RBA's Securitisation dataset are limited.

The CFR agencies continue to explore what other data and information could provide further insights on NBFI activity in the CRE sector.

NBFI use of OTC derivatives

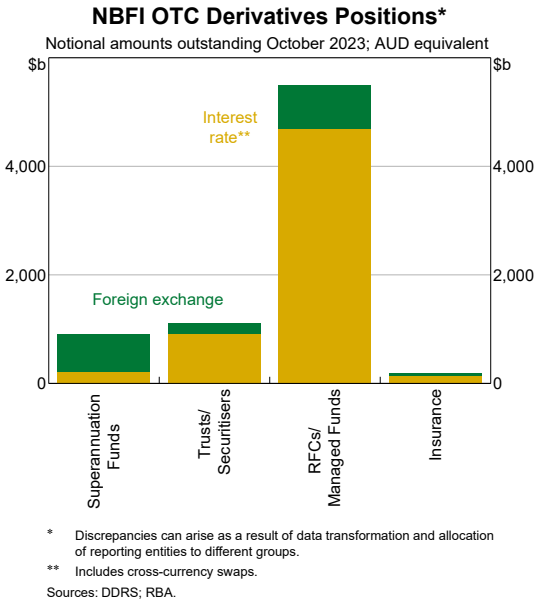
A number of stress episodes in global financial markets over recent years has highlighted the role that OTC derivatives can play in the build-up of financial system vulnerabilities (Choudhary, Mathur and Wallis 2023).[7] NBFIs operating in the Australian financial system were resilient through these disruptions. Data from trade repositories, along with APRA data and analysis by the Australian Securities and Investments Commission (ASIC) and the RBA, allow a mapping of NBFIs' OTC derivatives exposures, counterparties and practices, to assess the potential for a similar event here.

In the Australian market, the growing use of OTC derivatives by NBFIs appears primarily driven by

hedging and market-making activities and is unlikely to pose financial stability risks:

- NBFI positions were close to $7.8 trillion in notional value as of end October 2023, or over 10 per cent of the market.[8] The largest NBFI exposures have typically been from superannuation funds, managed funds, securitisation trusts and life insurance. Over the past five years, the notional value of all outstanding superannuation fund derivative contracts has increased by 50 per cent to close to $900 billion. More recent growth in activity by RFCs largely reflects that a domestic non-bank financial corporation has started offering market-making services for interest rate swaps; its contracts are all centrally cleared and include offsetting positions leading to considerable netting at the central counterparty and small residual directional market risk.
- Most NBFIs appear to use OTC derivatives primarily to hedge risks from their underlying activities, rather than for leveraged risk-taking.[9] Hedging positions are inherently less risky as losses on derivative contracts are offset by gains on underlying positions; they are also more stable than actively traded ones. However, they are not risk-free. There is still the potential for losses from counterparty credit risk and liquidity mismatches from large margin calls. NBFIs have many links with the real economy and banking system, which could exacerbate potential losses and make them more opaque. The exposures of most NBFIs are bilateral, through the intermediation of dealers, which provides limited netting opportunities and lacks the risk management benefits of central clearing.
- Foreign banks, and finance corporations affiliated with global banking groups, are among the most common counterparties in NBFI OTC derivative transactions. Australian banks also act as central nodes facilitating bilateral derivative transactions with NBFIs and non-financial corporations, including concentrated relationships with securitisers that typically use one bank to access interest rate hedges. The nature of bilateral markets can expose domestic banks to counterparty and market risks in the event that a large customer were to fail, and impair market access for customers if a domestic or global bank ceased offering these services.
- Interest rate swaps and FX products are the derivative types most used by NBFIs (Graph 6), with FX products the main source of market-risk exposure, partly reflecting the growth in foreign asset holdings by superannuation funds. During recent periods of volatility, FX contracts drove the largest mark-to-market fluctuations and related margin flows; however, superannuation funds mostly proved resilient to the large and sudden liquidity shock in March 2020, when the AUD depreciated resulting in $17 billion in margin calls.[10]

Graph 6



* Discrepancies can arise as a result of data transformation and allocation of reporting entities to different groups.
** Includes cross-currency swaps.
Sources: DDRS; RBA.

- NBFIs hold smaller notional outstanding amounts in other contract types, to generate returns rather than for hedging. NBFIs use equity swaps to build stock market exposure; superannuation funds hold some of the largest individual positions, but fully collateralise these with cash. NBFI positions in the smaller credit derivatives market are predominantly with foreign counterparties, with domestic banks less active in this segment. The commodity derivatives market appears very concentrated with few dealers offering services, but visibility

of related NBFI activity through available data is limited.

Continued monitoring of use of OTC derivatives

While there does not appear to be a material build-up of risks, several potential vulnerabilities in derivatives markets warrant continued monitoring. This includes the potential for:

- contagion from an interconnected network of bilateral exposures between NBFIs and banks
- liquidity mismatches from margin calls on large hedging positions (e.g. AUD hedges) or leveraged positions by certain NBFIs (e.g. hedge funds) leading to possible distressed sales of collateral
- severe consequences from macro-financial linkages between derivative products and underlying economic activity (e.g. commodity markets).

Ongoing monitoring of vulnerabilities in these markets is difficult, and work is planned to address visibility gaps. CFR agencies will continue to develop their internal analytical capabilities, and to strengthen and streamline data-sharing arrangements on OTC derivatives.

Work of regulatory bodies on addressing NBFI risks

Vulnerabilities at NBFIs, including leverage and liquidity mismatch, are viewed as a key risk to the global financial system, with NBFIs now accounting for around half of global financial system assets. The FSB continues to progress initiatives to improve NBFI resilience in association with international standard setting bodies, such as the Basel Committee on Banking Supervision and the International Organization of Securities Commissions (IOSCO). In September 2023, the FSB set out its policy priorities to address key amplifiers that may contribute to liquidity imbalances (FSB 2023a). These policies aim to enhance the resilience of liquidity supply in periods of stress and risk monitoring and preparedness by NBFIs and supervisors.

The FSB also released a report in September 2023 examining the financial stability implications of leverage in non-bank financial intermediation (FSB 2023b). The report identifies pockets of high leverage in the NBFI sector, including an increase in non-bank investors' off-balance sheet financial leverage. However, significant data gaps prevent a full assessment of vulnerabilities associated with NBFI leverage. This lack of visibility can contribute to the build-up of large, concentrated positions.

In the latest round of monitoring on NBFI vulnerabilities by the FSB's Non-bank Monitoring Expert Group, fintech and peer-to-peer (P2P) lending were the most reported innovations in the NBFI sector, though remain a small share of credit overall. In Australia, fintech credit is estimated to account for around 6 per cent of finance company credit assets. The FSB has committed to expand its annual collection to assess fintech vulnerabilities from 2024.

Over 2024 a key focus for the FSB is non-bank leverage. The FSB, working with IOSCO and FSB member jurisdictions, will undertake and coordinate policy work to monitor and address financial stability risks from leverage in NBFIs. The relevant CFR agencies, including the RBA, will contribute to this work program as appropriate. As already noted, NBFI risks in Australia are more contained. However, work continues by the CFR agencies to improve visibility of NBFI activity in Australia as part of their ongoing monitoring of developments in NBFIs and any potential systemic risks for the Australian financial system.

Conclusion

Overall risks to financial stability posed by the NBFI sector in Australia remain contained. The size of riskier NBFI activities in the Australian financial system remains modest and their interconnectedness with the core banking system has continued to decline. Australian non-banks' lending has shifted towards riskier market segments, but remains small as a share of outstanding credit. There have been limited signs of financial stress among NBFI owners of Australian CRE. However, there remains a risk that stress in overseas CRE markets could spill over into the domestic market. Further, the use of OTC derivatives by NBFIs is sizeable and growing, but appears primarily driven by hedging needs and market-making activities. CFR agencies, alongside regulatory bodies around the world, are continuing to monitor the vulnerabilities posed by NBFIs and progress work to address information gaps where possible.

Endnotes

[*] The authors are from Financial Stability Department. They would like to thank colleagues at CFR agencies for their helpful contributions.

[1] Payment systems are important providers of financial services but were out of scope for the analysis in this article.

[2] This refers to foreign and domestic intermediated debt funding. Some participants also issue debt in capital markets.

[3] Non-financial owners, while outside the scope of NBFIs, are also important to consider given their interlinkages with the banking system. For example, developers and property companies comprise a material share of the market and have the capacity to transmit stress to the banking system.

[4] Although most retail funds now have discretion to suspend redemptions, sustained requests for redemption could ultimately result in trusts disposing of assets at fire-sale prices.

[5] Aggregate gearing and funding sources for unlisted property trusts are estimated using data from the Australian Bureau of Statistics (ABS) and data from Morningstar on listed property trusts. Following recent consultation, the ABS has advised that the content, scope and coverage of data collected on investment funds will be reviewed to address data limitations. For further information, see ABS (2024).

[6] To address existing data limitations, ASIC (2023) has recommended introducing a legislative framework for the recurrent collection of data on managed investment schemes in its submission to Treasury on the review of the regulatory framework for managed investment schemes consultation, released on 4 August 2023.

[7] NBFIs use OTC derivatives to hedge risks from their primary activities, provide market-making services or build exposure to specific markets including interest rate, foreign exchange (FX), equity, commodity and energy markets. These contracts (e.g. swaps, forwards and options) cover periods ranging from a few days to over 30 years. Over the life of a contract, the counterparties to the contract are exposed to risks that need to be managed; among these, the risk that either counterparty defaults on its obligations (credit risk), large margin payments (liquidity risk), price volatility affecting the value of the contract (market risk) and potential failures in related processes (operational risk). For additional background on features and developments in the Australian OTC derivatives market, see Armour and Beardsley (2023) and Cole and Ji (2018).

[8] The Australian OTC derivatives market exceeded $60 trillion in October 2023 when measured as the notional value of all outstanding contracts. Domestic and foreign banks are the dominant players in all these markets, taking 'one side of the trade' in the vast majority of outstanding positions.

[9] While individual hedging contracts cannot be identified, analysis of available data suggests that, at a high level, the derivative portfolios of most NBFIs are consistent with hedging strategies. For example, superannuation funds hedge a portion of their exchange rate risk on foreign asset holdings, securitisers hedge interest rate mismatches between their assets and liabilities, and managed funds offer fixed income and overseas investment products with hedged options.

[10] APRA's updated investment governance prudential standard, which came into effect in January 2023, further strengthens the resilience and liquidity management of APRA-regulated Australian superannuation funds. The updated standard increases the robustness of funds' investment stress testing, liquidity management practices and asset valuations by ensuring internal processes are well defined, regularly reviewed and performed more frequently. Liquidity stress tests are also required under the updated standard. For information about APRA's consultation on the standard and the release of a supporting practice guide on 20 July 2023, see APRA (2023).

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Assessing Physical Climate Risk in Repo-eligible Residential Mortgage-backed Securities

Ronan McCarthy and Geordie Reid[*]

Photo: Juan Silva – Getty Images

Abstract

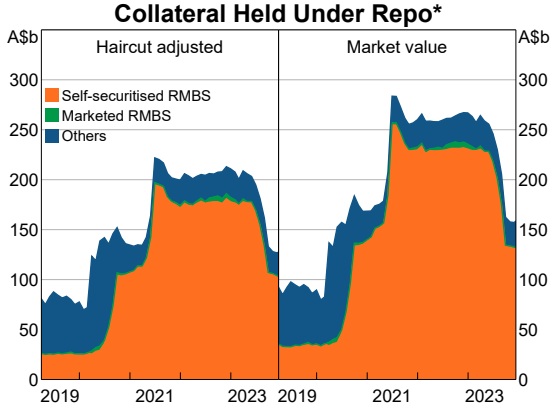
This article assesses physical climate risk in Australian residential mortgage-backed securities (RMBS) using two risk metrics. Based on these metrics, RMBS with higher levels of physical climate risk tend to be issued by small regional banks and credit unions. In addition, RMBS with higher physical climate risk do not appear to have additional credit enhancement. This could suggest that securitisation markets have yet to fully incorporate physical climate risk exposures into their assessments of RMBS, or that current climate risks are perceived to be small. However, the measure of climate risk used in this analysis is subject to several limitations and there is significant uncertainty about the future path and impact of climate change. This analysis is a first attempt at quantifying climate risk present in Australian RMBS and is part of ongoing work at the RBA to assess the effect of climate change on the financial system.

Introduction

Understanding climate risks carried by residential mortgage-backed securities (RMBS) – a collection of bonds 'backed' by principal-and-interest payments on mortgage loans – is important for pricing them correctly. The RBA has some exposure to RMBS via their use as collateral in the RBA's market operations. The RBA undertakes transactions in domestic financial markets to implement monetary policy and provide liquidity to the financial system. This usually involves lending cash to counterparties in exchange for collateral through repurchase agreements (repos). In recent years, a significant share of collateral provided by market participants has been RMBS (Graph 1). This includes self-securitised RMBS (self-secs), which were a large share of collateral provided to access the Term Funding Facility and could potentially serve as a source of eligible collateral in future periods of stress.[1] Publicly traded (or 'marketed') RMBS are also eligible collateral for the RBA's regular liquidity operations. RMBS noteholders are exposed to a range of risks, most of which are well known, but climate risk is less well understood. The RBA's exposures to these assets means that understanding the risks carried by RMBS, including climate risks, is important for the RBA as well as for the financial sector more broadly.

Graph 1

Collateral Held Under Repo*



* Data as of 31 December 2023.
Source: RBA.

How climate change could affect RMBS

The residential mortgages that underlie RMBS are exposed to physical climate risks in various ways.[2] The underlying properties may be exposed to acute climate events, such as flooding, cyclones and bushfires. These events are expected to become more frequent and/or severe with climate change. Some properties are also exposed to chronic risks, such as rising sea levels or land subsidence from decreased rainfall. Climate risk exposures can decrease property values and reduce a borrower's ability to service their debt through a range of channels. These include increased insurance, maintenance and repair costs, reduced demand from prospective buyers and tenants to live in locations more exposed to climate risk, and climate-related disruptions to economic activity affecting jobs and incomes. In cases where the mortgage has been securitised, these risks could be passed through to holders of RMBS, including those holding these assets as collateral, such as the RBA.

However, multiple factors help to mitigate risks to RMBS noteholders:

1. Defaults on insured mortgages will only pass through to the RMBS if the property is sold below the outstanding value of the loan and the mortgage insurer fails to pay out the difference.
2. Structural features of RMBS in the Australian market provide credit support to senior noteholders in particular.[3]

Additionally, from the perspective of the RBA:

3. The RBA does not buy RMBS outright so is only directly exposed to RMBS after a counterparty defaults. In this rare scenario, the RBA's direct exposure would remain until the security matures or is liquidated by the RBA.
4. The RBA requires RMBS to maintain a AAA-credit rating to continue to be repo-eligible, applies margins (i.e. haircuts) to the collateral value received and makes daily margin calls if the collateral value falls.

Previous work by the RBA investigated the potential physical climate risks to commercial banks' loan books, finding that overall losses for the financial

system due to climate-related declines in property values are likely to be manageable (Bellrose, Norman and Royters 2021). The analysis in this article builds on that earlier work, using a similar dataset and assumptions, to assess physical climate risk inherent in RMBS that are eligible as collateral in the RBA's market operations. We focus on physical climate risks to RMBS, where the underlying pool of mortgages may face more concentrated risks than the mortgage market as a whole, and extend the analysis to include non-bank lenders, for which RMBS are an important source of funding.

Data

Following Bellrose, Norman and Royters (2021), the main climate risk measure used in this analysis is the annual Value at Risk (VaR). In this context, VaR represents a technical insurance premium, which is an estimate of the annual expected cost of damage from all climate-related hazards relative to the replacement cost of a dwelling.[4] These data were sourced from XDI-Climate Valuation and assess the combined VaR from seven hazards in Australia.[5] The second measure used is the proportion of 'high-risk' properties (HRP) per postcode. A property is considered high risk if the annual VaR is greater than 1 per cent, following the definition used by Bellrose, Norman and Royters (2021).

XDI-Climate Valuation provide VaR estimates at five-year frequencies from 1990 to 2100. Risk estimates for 2020 are used as the measure of current climate risk exposure as this is the most recent period in the XDI-Climate Valuation dataset where VaR estimates are based on observed climate data. The average VaR across all Australian properties in 2020 was 0.22 per cent, equating to an annual technical insurance premium of $1,075 for a property that would cost $500,000 to replace.[6] Meanwhile, around 4 per cent of all dwellings in Australia were considered HRP in 2020. These Australia-wide averages are used as a reference point in the analysis that follows.

VaR estimates for 2050, a common reference point for climate scenarios, are used to measure exposure to future climate risk. The 2050 projections are based on the Intergovernmental Panel on Climate Change Representative Concentration Pathway (RCP) 8.5 scenario.[7]

Detailed loan-level data on around 2.5 million securitised residential mortgages were sourced from the RBA's Securitisation System.[8] This captures approximately two-thirds of the public RMBS market in Australia, in addition to self-securitisations, and covers around one-third of Australian residential mortgages by value. For this analysis, relevant attributes include the RMBS deal the mortgage belongs to, the postcode of the underlying property, the outstanding loan balance, and other common features used to assess credit risk.

Measuring current climate risk in RMBS

For this analysis, the datasets described above are combined to compute two metrics of climate risk for each of the 283 repo-eligible RMBS deals in the Securitisation System as of 31 December 2023:

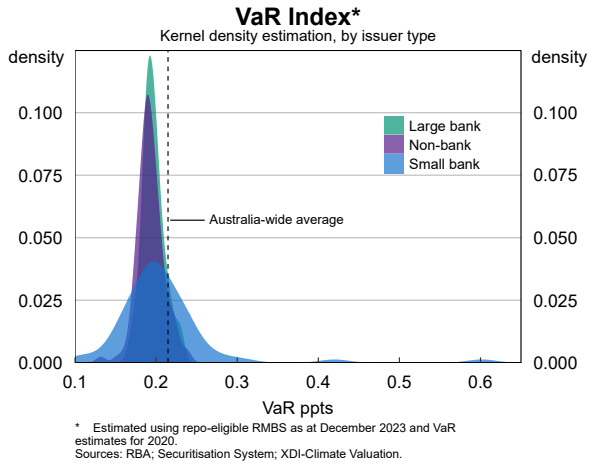
1. **The VaR index.** This is the average of the postcode-level VaR of each mortgage in an RMBS, weighted by loan balance outstanding.
2. **The HRP index.** This measures the proportion of properties in an RMBS with a VaR exceeding 1 per cent, weighted by loan balance outstanding.

The analysis was conducted at a postcode level due to the privacy considerations around analysing the data at a more granular geographic resolution, such as property level. The VaR index is our preferred metric as it represents a direct estimate of physical climate risk. However, the HRP index provides a cross-check against any aggregation bias in the VaR index; for example, if a postcode contains a number of very low-risk and very HRP, the VaR index may understate the climate risk of an RMBS. Further details about these metrics are provided in Appendix A.

The average VaR index across all RMBS in the dataset was 0.2 per cent as of 31 December 2023, which is slightly below the Australia-wide average (Graph 2).[9] Results are broken down by 'issuer type' (or, more accurately, the sponsoring entity of the RMBS) to assess whether meaningful differences exist.[10] RMBS issued by large banks and non-banks

have VaR index values largely clustered around the mean. By contrast, those issued by small banks exhibited larger variation in the VaR index, as discussed further below. The highest risk RMBS had a current VaR index value roughly three times higher than the Australian average. This equates to a technical premium of over $3,000 annually for a property that costs $500,000 to replace.

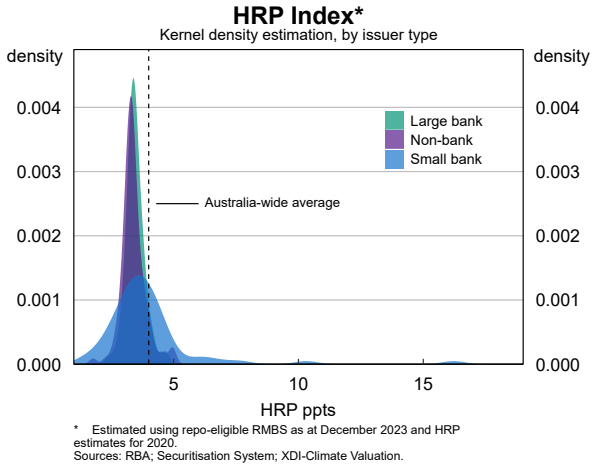
Graph 2



* Estimated using repo-eligible RMBS as at December 2023 and VaR estimates for 2020.
Sources: RBA; Securitisation System; XDI-Climate Valuation.

Similarly, the average proportion of HRP among RMBS was slightly below the Australia-wide average (Graph 3). RMBS issued by small banks contained a larger proportion of HRP than those from other issuer types at 4 per cent. The HRP index for the most 'at risk' RMBS was over 15 per cent, indicating that roughly one in six mortgages in that loan pool are secured against a property located in a high-risk postcode.

Graph 3



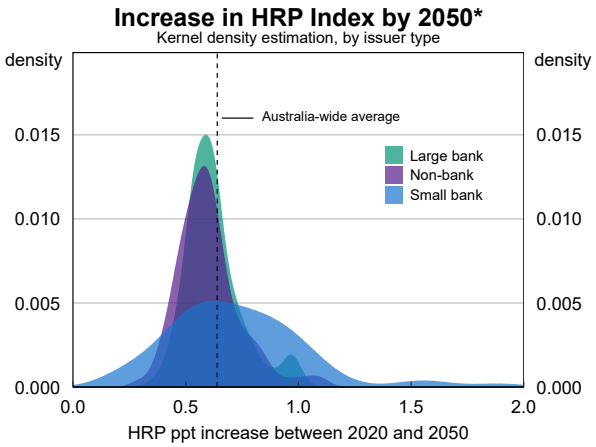
* Estimated using repo-eligible RMBS as at December 2023 and HRP estimates for 2020.
Sources: RBA; Securitisation System; XDI-Climate Valuation.

Future climate risk in RMBS

Next, we investigated how the risk profile of RMBS would change under a high emissions scenario where physical climate risks increase by 2050, assuming the composition of mortgages in the RMBS portfolio stays fixed. While this is a strong assumption, as the lending decisions of financial institutions will be likely to adapt to a changing risk profile, this analysis can also be thought of as a stress test on current RMBS loans pools if climate risks were realised more quickly than expected.

In this scenario, both the universe of repo-eligible RMBS and the Australia-wide average see a 25 per cent increase in annual VaR by 2050, or around 0.05 percentage points. As the VaR is an expected annual cost of climate-related damages, the increased technical premium costs would be incurred incrementally in each year. Similarly, the share, by value, of HRP in RMBS would increase by an average of 1.25 percentage points and by between 1.5 to 2 percentage points for a small number of securities by 2050 (Graph 4).

Graph 4

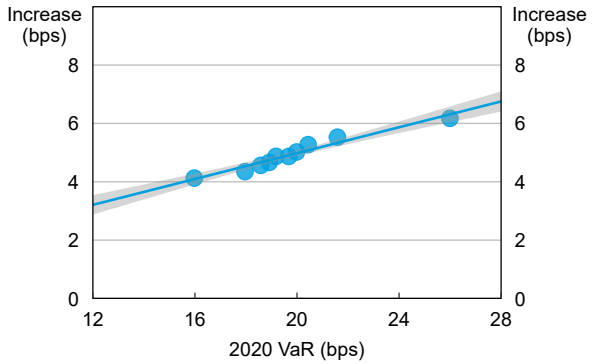


* Estimated using repo -eligible RMBS as at December 2023.
Sources: RBA; Securitisation System; XDI-Climate Valuation.

Overall, the ordering of RMBS by VaR does not materially shift in the 2050 scenario. For instance, the seven RMBS with highest current risk using the VaR index remain the same in 2050. This reflects the positive relationship between current risk and change over time; deals with greater exposure to physical risks today face a greater increase in these risks over time (Graph 5).

Graph 5

VaR Index*
Current level and change by 2050



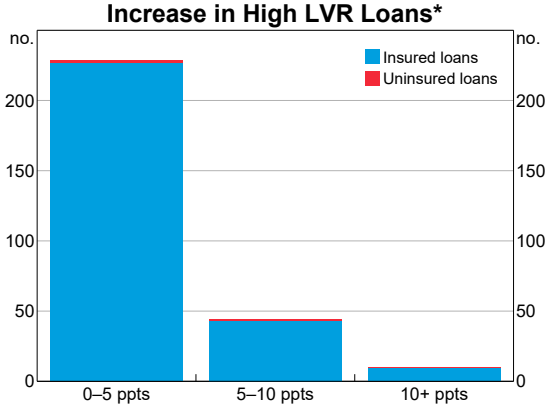
* Dots indicate increase in VaR by decile by 2050 (deciles based on current VaR).The fitted line is computed based on individual RMBS data and the shaded area represents the 95 per cent confidence level around the fitted line. RMBS data as of December 2023.
Sources: RBA; Securitisation System; XDI-Climate Valuation.

Impact on borrower leverage

Bellrose, Norman and Royters (2021) estimated that an increase in VaR of 0.4 percentage points is equivalent to roughly a 10 per cent decline in housing prices in real terms.[11] Assuming this relationship holds, in the above scenario this would equate to an average decline in housing prices of roughly 1.25 per cent across all RMBS, and 2 per cent for the RMBS with the largest VaR increase. We translated the potential decline in housing prices into an implied increase in borrower leverage for each loan in our sample, as measured by loan-to-value ratios (LVRs). Graph 6 presents these results for each RMBS, expressed as the sum of loan balances of high LVR mortgages (those with LVR > 80 per cent) as a proportion of the value of the total loan pool. These results suggest that higher physical risk could increase the proportion of high LVR mortgages in RMBS by 2.75 percentage points, on average, with this proportion increasing by 15 percentage points in one RMBS.

Graph 6

Increase in High LVR Loans*



* Estimated increase in the share of mortgages with an LVR greater than 80 per cent, by 2050, for each RMBS under a high emissions scenario.
Sources: RBA; Securitisation System; XDI-Climate Valuation.

Notably, however, almost all loans that move into the high LVR category in this scenario have some level of lenders' mortgage insurance (LMI) coverage, mitigating risks to RMBS noteholders. There is also considerable uncertainty in the likelihood of the high physical risk scenario and in the modelled effect on housing prices. We model housing price declines as a function of higher insurance premiums, ignoring other possible effects of physical or transition risk. Furthermore, these RMBS and their respective mortgage loan pools are unlikely to exist in their current form by 2050. Thus, as noted earlier, it is best to consider this exercise as akin to a stress test, rather than a prediction.

Features of RMBS with more exposure to climate risk

Table 1 presents characteristics of RMBS with high levels of climate risk, which we define as those with a VaR index value more than two standard deviations above the mean. These 'high-risk' deals are all issued by small banks, despite small bank-led deals constituting only about 20 per cent of all repo-eligible RMBS by number. These 'high-risk' RMBS possess a relatively high degree of loan concentration in non-metropolitan areas, reflecting the generally smaller geographic footprint and less diversified nature of small regional banks and credit unions. All 'high-risk' RMBS contain a heavy concentration of loans in at least one of four regional areas in Australia, highlighting the geographic concentration of climate risk. A number of these RMBS are held as collateral on the RBA's

Table 1: RMBS with Greatest Exposure to Physical Risks

Data to December 2023

Attribute	All RMBS	'High-risk' RMBS[(a)]
VaR index	0.20%	0.40%
HRP index	3.55%	10.25%
Total repo collateral value[(b)]	$129b	$0.25b
Total face value[(c)]	$613b	$2b
Non-metropolitan loans share[(d)]	27.2%	72.9%
LMI insured loans share	30.0%	11.8%

(a) RMBS with a VaR index value of more than two standard deviations above the mean.
(b) Market value of collateral held under repo, rounded to the nearest $50 million.
(c) Face value of all repo-eligible RMBS, rounded to the nearest $50 million.
(d) Proportion of loans located outside Greater Capital City Statistical Areas as defined by the Australian Bureau of Statistics.

Sources: RBA, Securitisation System, XDI-Climate Valuation.

balance sheet. However, the market value of this collateral represents only a small share – less than 0.1 per cent – of all domestic collateral held on the RBA's balance sheet as of December 2023.

Relationship with other risk metrics

If RMBS loan pools with higher exposures to climate risk are also risky in other dimensions, then they may pose greater risk of losses to noteholders if climate risks are realised. Overall, we find no simple relationship between climate risk and conventional risk metrics, as summarised in Table 2.

Climate risk has a small positive relationship both with the proportion of loans located in non-metropolitan areas, and with geographic concentration. However, the relationship between climate risk and geographic concentration is not straightforward. For example, while RMBS issued by small banks feature higher levels of both climate risk and geographic concentration, non-bank issued deals have high geographic concentration, but relatively low exposure to climate risk. This may be because the mortgage pools underlying non-bank RMBS are largely concentrated in regions with lower climate risks, such as metropolitan areas. While not presented in Table 2, among banks that have issued both a self-securitised and marketed RMBS, the level of climate risk across the two deal types is similar.

Credit enhancement of RMBS more exposed to climate risks

While discussion of RMBS risk often focuses on the quality of the loan pool, structural features of RMBS play an equally significant role in determining the risks facing the noteholders of the security. Australian RMBS use multiple credit-enhancing features to mitigate risk (Arsov, Kim and Stacey 2015). A common form of credit enhancement is subordination, where mortgage loan losses are allocated to junior notes before senior notes; the junior notes are said to provide 'credit enhancement' to the senior note by shielding it from losses arising from the underlying pool. If rating agencies penalise climate risk exposure in their rating requirements, or if investors demand greater protection against climate risk, 'at-risk' RMBS would likely be structured with more credit enhancement. To investigate this, we estimated the regression model detailed in Appendix B.

The results from this exercise indicate that deals with a higher VaR index do not attract a higher level of subordination, perhaps suggesting that climate risk is not accounted for with higher credit enhancement or that climate risks are perceived to be small. In contrast, conventional credit quality metrics – such as the LVR, the proportion of non-conforming loans, and loans in arrears – have a statistically significant impact on credit enhancement in repo-eligible RMBS.[12]

Table 2: Comparing Risk Metrics Across Issuer Types

Data to December 2023

Risk metric	Large banks	Small banks	Non-banks
Climate risk metrics			
VaR (%)	0.196	0.209	0.193
HRP (%)	3.46	4.00	3.39
Other risk metrics			
Geographic concentration index[(a)]	–0.47	0.28	0.17
LVR	51.8	53.5	61.8
Non-conforming (%)	2.5	4.7	37.3
LMI insured (%)	35.4	46.2	15.3
Seasoning (months)	94.1	75.2	46.4
>30 days arrears (%)	1.14	0.49	2.17
Non-metropolitan loans (%)	26.8	39.8	24.9
Number of deals	94	64	106

(a) A positive value indicates higher geographic concentration than the mean, a negative value indicates lower concentration than mean. Appendix C provides further details on the measure of geographic concentration.

Sources: RBA, Securitisation System, XDI-Climate Valuation.

Limitations

This analysis is a first attempt at quantifying climate risk present in RMBS and is subject to a number of limitations that may affect our findings and provide a basis for future research.

There are several factors that may lead our metrics to overstate the level of climate risk. The VaR measure excludes land values and so may overstate the level of housing price decline estimated under the user-cost framework. Also, current housing prices may already reflect some level of expected future climate risk, especially in high-risk areas where access to, and affordability of, insurance is a growing concern. In addition, risks in RMBS may change over time as lenders change their lending policies, including in response to rating agency and investor preferences.

This analysis may also understate climate risks in various ways. For privacy reasons, we assigned climate risk to a mortgage based on the average VaR of the property's postcode. This smooths over the actual level of risk for each property, as within a postcode some properties are much more exposed to climate risk than others. Typically, mortgages sustain losses when both collateral values and borrower income decline (Read, Stewart and La Cava 2014). Severe natural disasters can have wider impacts in a region if economic activity is disrupted, which could reduce borrowers' incomes. Longer term chronic climate change could also reduce borrowers' incomes – for example, in regions affected by heat stress and associated declines in labour productivity. We also do not account for transition risk, which may have differing effects across regions on both incomes and property values, particularly in regions with high levels of employment in emissions-intensive industries. Finally, the future availability and affordability of property insurance is another factor that we have omitted from this analysis and could be considered in future work.

More broadly, there is considerable uncertainty around the likelihood of any specific scenario occurring and around predicting the impacts of a given scenario. In addition, we have explored only a small number of metrics for quantifying the risks of climate change. All this suggests a degree of caution is warranted when interpreting the results presented here.

Conclusion

In this analysis, we constructed two indices to assess physical climate risk in RMBS, which are eligible as collateral in the RBA's liquidity operations. Our results suggest that RMBS with higher levels of physical climate risk tend to be issued by small regional banks and credit unions, rather than large banks or non-banks. In general, climate risk does not correlate with conventional credit risk metrics, but moderately correlates with some concentration risk variables, such as non-metropolitan loan concentration and geographic concentration.

Overall, the impact of increasing physical climate risk on housing prices for securitised mortgages is estimated to be small. We estimated, in a simple scenario analysis, that the expected increase in physical risks by 2050 would reduce average housing prices by no more than 2 per cent in all repo-eligible RMBS. This measure only captures housing price falls due to increased insurance costs from physical climate risks and ignores transition risk and other possible impacts of physical risk, such as reduced incomes. While the share of high LVR loans would increase in this scenario, the increase is small. Almost all loans that become (or remain) high LVR have some level of LMI, mitigating the increase in direct risks to RMBS noteholders.

Finally, we investigated the relationship between climate risk exposures and credit enhancement from the subordination of junior notes. Our analysis suggests that AAA-rated notes in RMBS with higher climate risk do not benefit from additional subordination of junior notes. This might suggest that securitisation markets have yet to fully incorporate climate risk exposures into their assessments of RMBS, or that climate risks are perceived to be small.

We note, however, that this is a first attempt at quantifying physical climate risk in RMBS and it is subject to several limitations. There is considerable uncertainty both in the construction of our measures of climate risk and in the future impacts of climate change. Future analysis could add to this work, for example by using more granular data to measure physical climate risk, better understanding how markets are currently pricing climate risk, or by extending the coverage to account for transition risks.

Appendix A: Risk metrics

For this analysis, we constructed two risk metrics. First, we created a *VaR index* as a weighted average of the postcode-level VaR of each mortgage in an RMBS, using the following equation:

$$VaR\ index_r = \frac{1}{\sum_{i=1}^{N} B_{r,i}} \sum_{i=1}^{N} B_{r,i} VaR_{r,i}$$

where:

- B is the outstanding loan balance
- r is a given RMBS
- i is a given mortgage within an RMBS r
- *VaR* is the annual climate value-at-risk at postcode level.

For each mortgage in a given RMBS, we multiplied the outstanding loan balance by the average VaR of the postcode in which the underlying property is located and took the sum for all mortgages. This was divided by the aggregate outstanding loan balance of mortgages in the RMBS.[13]

Our second risk metric, the *HRP index*, measures the proportion of properties in an RMBS with a VaR exceeding 1 per cent, also weighted by value, using the following equation:

$$HRP\ index_r = \frac{1}{\sum_{i=1}^{N} B_{r,i}} \sum_{i=1}^{N} B_{r,i} HRP_{r,i}$$

where:

- *HRP* is the proportion of mortgages in a postcode with VaR > 1 per cent
- other variables are as for the *VaR index* above.

Appendix B: Regression specification and output

The following log-log regression model was run to estimate whether RMBS with higher current VaR index values attract a higher level of subordination:

$$log(CE_r) = \alpha + \beta log(ClimateRisk_r) + \gamma log(X_r) + \delta D_r + \theta T_r + \epsilon_r$$

where, for each RMBS *r*:

- CE_r is the original subordination of junior notes to unsubordinated notes
- $ClimateRisk_r$ is the VaR index for year 2020
- X_r is a set of quantitative loan pool risk metrics as of 31 December 2023
- D_r is a pair of issuer-type dummies indicating whether an RMBS is issued by a non-bank or a small bank
- T_r is a time dummy switched on for RMBS issued after the first Australian *green* RMBS issuance in 2018.

The full regression results are set out in Table B1.

Table B1: Subordination Model Coefficients[(a)(b)]

Data as of 31 December 2023

Predictors	Estimates
Climate risk	−0.12
	(0.914)
LVR	0.81***
	(0.004)
Non-conforming	0.08***
	(0.005)
>30 days in arrears	0.14*
	(0.052)
Geographic concentration	−0.12*
	(0.069)
Deal size	−0.10**
	(0.022)
Time *dummy*	−0.20***
	(0.002)
Non-bank *dummy*	0.34***
	(0.000)
MLH bank *dummy*	−0.12*
	(0.076)
(Intercept)	−0.76
Observations	232
R^2 / R^2 adjusted	0.55 / 0.54

(a) *, **, *** indicates statistical significance at the 10, 5, and 1 per cent level respectively. P-values in brackets.
(b) Non-dummy coefficients represent the elasticity of subordination with respect to the risk variable.

Sources: RBA, Securitisation System, XDI-Climate Valuation.

The results indicate that non-bank-issued RMBS attract a higher degree of credit enhancement, and the opposite is true for those issued by small banks. These results are consistent with markets perceiving RMBS that are issued by prudentially regulated entities to possess loan pools that are originated with higher quality lending standards. RMBS issued since the time *dummy* cut-off in 2018 (when the first green RMBS was issued in Australia) are structured with less credit enhancement. This possibly indicates a softening of subordination requirements in the market over the sample issuance range, though other factors might explain this reduction, such as Australian regulators' housing lending policies (RBA 2018). We leave future research to investigate this further.

Appendix C: Measuring geographic concentration

The geographic concentration index used in this analysis measures the degree to which loans in an RMBS are geographically clustered. It is normalised such that an RMBS with mean concentration would have a value of 0 and the distribution has a standard deviation of 1. The index for a single RMBS takes the form of a gravity model:

$$Index = \frac{1}{N}\sum_{i \neq j} \frac{\sqrt{v_i v_j}}{d_{ij}}$$

where d_{ij} measures the straight-line distance between each pair of properties i and j in the deal. Each of these inverse distances are weighted by the geometric mean of the gross loan balance for each property.

Although a granular measure, a limitation is that geographic concentration is considered only through the lens of physical distance. A more robust approach might also consider how the distribution of loans compares against the distribution of properties across Australia.

Endnotes

[*] The authors are from the Risk and Compliance and Financial Stability departments. They would like to thank Mark Hack, Chris Stewart, Andrew Sewell and other colleagues for their helpful input. Thanks also to XDI-Climate Valuation for providing the climate risk data used in this analysis.

[1] Self-secs are created by authorised deposit-taking institutions (ADIs) specifically to be offered as collateral to the RBA. Self-secs are only eligible as collateral where a related-party exemption has been granted for specific purposes, such as for Exceptional Liquidity Assistance or the Term Funding Facility (RBA 2024).

[2] Climate-related financial risks are typically broken down into *physical risks*, arising directly from changing weather and climate patterns, and *transition risks* arising from changes in policy, technology, or investor and consumer preferences. Contat *et al* (2023) survey recent literature on climate risks to real estate, while Eren, Merten and Verhoeven (2022) provide an overview of the pricing of climate risks in financial markets.

[3] For more information about structural features of Australian RMBS, see Arsov, Kim and Stacey (2015).

[4] Actual insurance premiums paid by homeowners are comprised of both hazard and non-hazard costs and would therefore be higher than the estimated VaR. Actual premiums also differ from the estimated technical premium due to factors such as consumer preferences, insurers' varying product offerings and incorrect pricing (Paddam, Liu and Saroop 2023).

[5] These are coastal inundation, cyclone wind, extreme wind, forest fire, riverine flooding, soil subsidence, and surface (flash) flooding.

[6] This is calculated as the average across all 2,639 postcodes in the XDI-Climate Valuation data, weighted by the number of properties in each postcode. As such, this average effectively gives equal weight to each property in Australia.

[7] The RCP 8.5 pathway describes a scenario where planetary warming increases by an average of 8.5 watts per square metre across the planet, resulting in a temperature increase of about 4.3°C by 2100. This scenario is seen as unlikely by climate scientists, but may represent a world where the climate is more sensitive to emissions than currently assumed. We use this scenario as a stress test exercise.

[8] Since June 2015, the RBA has required that detailed information about an asset-backed security's structure and underlying assets be made available for the security to be eligible as collateral in the RBA's domestic market operations. Securitisation System data is available (free of charge) to permitted users, including for academic research. For more information, see Fernandes and Jones (2018).

[9] This is not strictly comparing like-to-like, as the Australia-wide VaR is calculated as an unweighted average.

[10] RMBS are issued out of a bankruptcy remote trust or company created solely to hold assets on behalf of secured creditors. We define large banks as ADIs that are subject to the Australian Prudential Regulatory Authority's (APRA) Liquidity Coverage Ratio requirement. Small banks are smaller and less sophisticated ADIs that are subject to APRA's Minimum Liquidity Holdings (MLH) requirement, while non-banks are other institutions that are not authorised to take customer deposits.

[11] The user cost framework proposes that prices are at their 'fundamental' value when 'user costs' are equal to the rental yield (Fox and Tulip 2014). Bellrose, Norman and Royters (2021) assume a starting rental yield of 4 per cent and use the forecast increase in VaR as the associated increase in the rental yield via increased insurance premiums.

[12] Notably, the model suggests that geographic concentration does not attract higher subordination, which stands in contrast to the stated methodology of rating agencies. A possible explanation is the difference in how geographic concentration is measured in the RBA's internal model used in this analysis and how rating agencies assess geographic concentration. See Appendix C.

[13] The loan balance is defined as the sum of due principal, interest, any penalty interest and all other fees and costs charged to the loan balance.

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The Private Equity Market in Australia

Jacob Harris and Emma Chow[*]

Photo: Roberto Moiola / Sysaworld – Getty Images

Abstract

The Australian private equity market has grown significantly for a number of years, particularly as the economy recovered from pandemic-related disruptions. Consistent with this growth, private equity deals involving Australian companies have increased in value, and private equity funds have raised larger amounts of capital from investors. Recently, however, private equity activity has declined substantially as borrowing costs increased. Over recent years, international private equity firms and investors have also increased their presence in the Australian market. This article discusses these developments in the Australian private equity market and considers the implications that a robust private equity market may have on Australian businesses and public capital markets.

Introduction

Australian companies benefit from deep, high-quality capital markets in which they can raise funds to support their operations and expand their business. A key component of this is the Australian equity market, in which companies raise money from investors in return for part-ownership of the company's profits and assets. Companies listed on the Australian Securities Exchange (ASX) are some of the most visible businesses in Australia. Listed companies tend to be large, mature businesses that benefit from having their shares trade in a liquid and transparent public market.

Issuing shares on a public exchange, however, may not be the best way to raise capital for all companies. Some companies prefer to raise private equity capital, which generally involves a smaller number of investors, who therefore obtain more control over the company. This can be a particularly important source of funding for smaller or riskier businesses that may face greater costs and other challenges in raising capital in public markets.

While it remains much smaller than the public market, the Australian private equity market has grown significantly over recent years. Assets under management in Australian-focused private equity funds – an important component of the private equity market – have nearly tripled in size since 2010 to $66 billion (for comparison, the combined market capitalisation of companies listed on the ASX is $2.7 trillion).[1] This has occurred alongside substantial growth in private equity fund raisings and deals with Australian companies.

What is private equity?

Private equity is ownership or interest in a company that is not transacted in a public market. These companies are often small, new, or otherwise riskier businesses.[2] They may not have enough collateral or a track record of profits to qualify for bank financing, and other forms of debt funding may be prohibitively expensive. While internal equity financing through retained profits is often the cheapest source of funds, this can be impractical for companies with negative cashflows or businesses trying to grow quickly.[3] As such, private equity financing is an important source of funding for some companies' operations and growth. While companies can obtain private equity financing from a variety of non-institutional sources – such as friends, family members, and angel investors – the most prominent investors are private equity firms.[4]

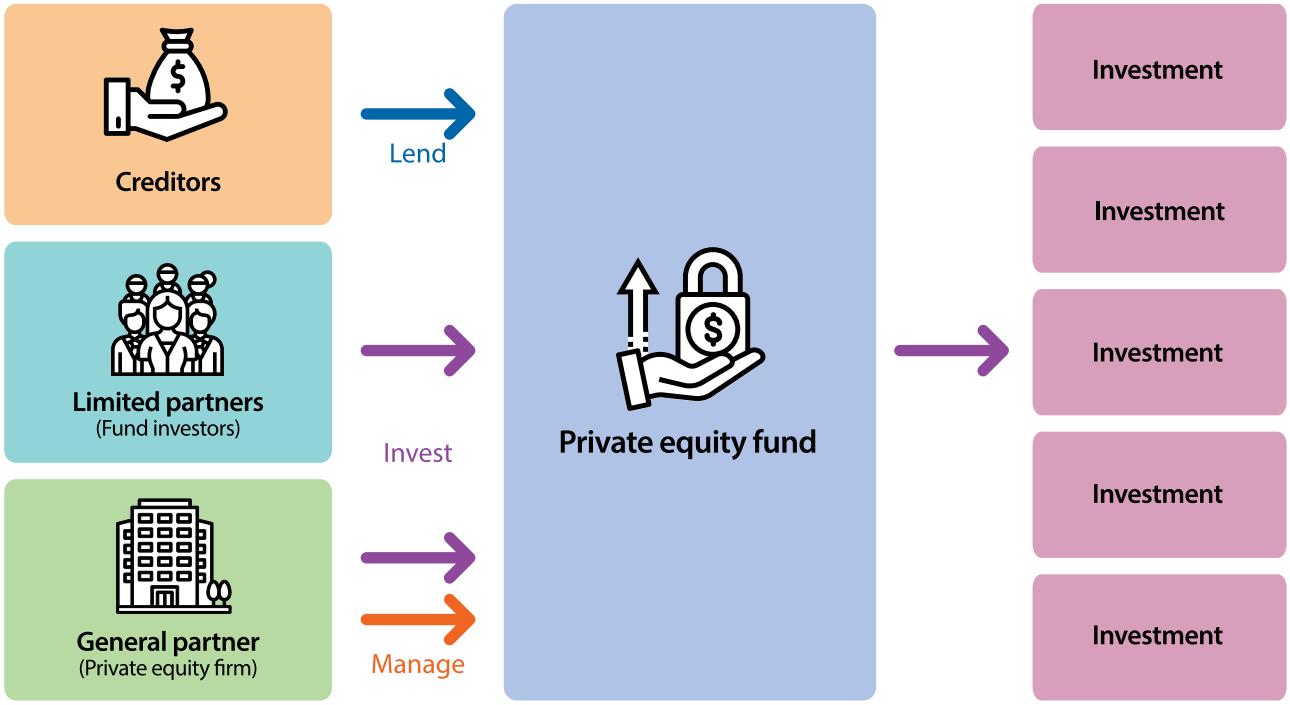
Private equity firms may raise capital for their investments through a combination of equity and debt. The equity component is typically raised from a range of external investors (limited partners) – such as superannuation funds, wealth managers and high net-worth individuals – as well as from the private equity firm itself (general partner) (Figure 1). This equity component may be supplemented with debt financing to increase the total amount of capital available for investment. Private equity firms generally invest in a portfolio of companies and distribute the returns on these investments, after costs, to the investors. The main external investors in Australian private equity funds are institutional investors, particularly superannuation funds and foreign institutions. The prevalence of institutional investors reflects, in part, the fact that private equity funds require a relatively high minimum contribution (subscription) from investors; these investments are also relatively illiquid, with investors typically required to lock their money away for a number of years. Retail investors in Australia nonetheless have some indirect exposure to private equity funds through the funds management industry and listed private equity investment companies.

Private equity firms invest the capital for each fund into a portfolio of companies that satisfies the fund's mandate, such as indicators of growth potential. Investment decisions are normally managed and executed by the general partner of the fund (the private equity firm), with the limited partners (fund investors) paying management and performance fees to the private equity firm for these services. Private equity investments range from a minority stake in a business to buying out an entire company, and can be grouped into three broad categories:

1. **Venture capital.** This involves investment in early-stage or growing companies with strong long-term growth potential.
2. **Buyouts.** These involve the purchase of at least a controlling interest of an established (and often listed) company, often with the intention of improving operations and/or financials before selling the company for a profit. The largest of these transactions are generally leveraged buyouts, which tend to be financed with some equity and a significant amount of debt.
3. **Other private equity.** This involves raising new equity capital to fund further growth opportunities, such as acquisitions, or to improve the company's capital structure.

The objective of a private equity firm is to generate a return on their investments, potentially through selling their equity ownership at some point in the future at a profit. Private equity firms often take some degree of control in the management of a company, with the aim of improving its growth prospects and profitability. Changes may be made to operations and capital structure, staff and management, or the level of investment in research and development to improve a company's

Figure 1: Private Equity Fund Structure



Source: RBA.

products. Upon selling their investments, the firm will distribute net returns to the investors in its fund.

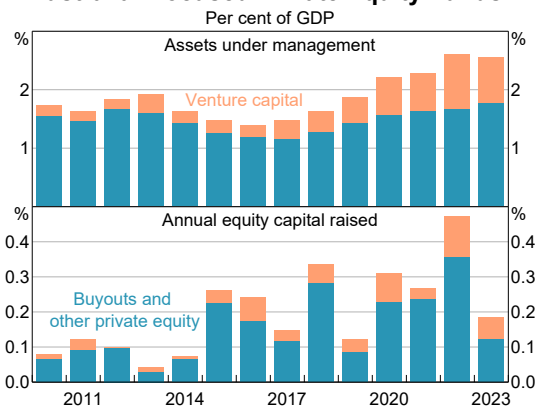
Size of and trends in the Australian private equity market

The Australian private equity market has seen significant growth in recent years, particularly as the economy recovered from pandemic-related disruptions.[5] As an indication of market size, private equity funds (both domestic and foreign) with a focus on investing in Australian companies had around $66 billion in assets under management as at June 2023, representing 2.6 per cent of GDP (Preqin and AIC 2024).[6] This comprised around $44 billion in funds already invested in Australian companies, and $22 billion in funds yet to be invested. Nominal assets under management for these funds grew by around 75 per cent from December 2019 to June 2023, with notable growth in venture capital funds (Graph 1, top panel).

While some of this growth stemmed from the returns on the investment portfolios, fund raising has also been a driver in recent years. Aggregate capital raised by private equity funds that have an Australian focus was a record $11.7 billion (0.5 per cent of GDP) in 2022 (Graph 1, bottom panel). This is significantly higher than the $4.1 billion annual average (inflation-adjusted to 2022) over the prior decade. It also greatly exceeded the amount of capital raised on the public equity market through initial public offerings, which, at roughly $1 billion in 2022, was well below the $9.8 billion annual average (inflation-adjusted to 2022) over the prior decade.

Graph 1

Australian-focused Private Equity Funds*



* Private, closed-end funds that predominately focus on Australia. Final AUM observation is as of 30 June 2023.

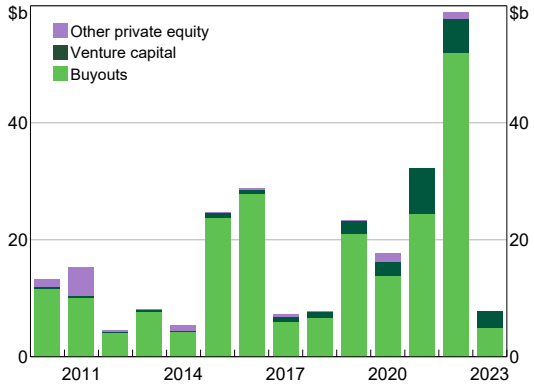
Sources: ABS; Preqin; RBA.

Consistent with the growth in private equity funds with a focus on investing in Australian companies, the value of private equity deals involving Australian companies has increased to a record high in recent years. The total value of private equity deals was $57 billion (2.3 per cent of GDP) in 2022 (Graph 2). This growth was primarily driven by a small number of large leveraged buyouts, in which private equity firms take on more debt to purchase a controlling stake in an established Australian company. Since 2023, however, private equity activity has declined, partly due to higher debt servicing costs.

Graph 2

Australian Private Equity Deals*

In 2023 dollars



* Values include both equity and debt components of deals involving Australian companies. Observations are adjusted using CPI growth.

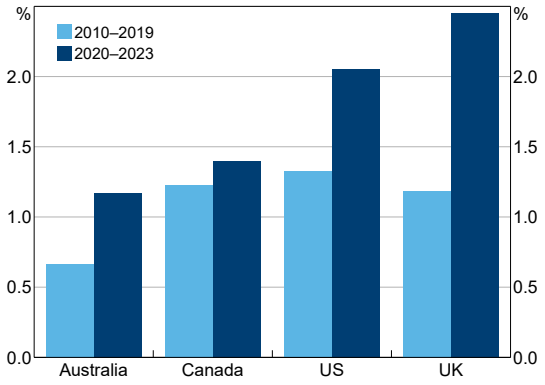
Sources: ABS; LSEG; RBA.

The earlier strength and most recent decline in the Australian private equity market has mirrored private equity activity in other developed equity markets (Graph 3). Earlier strength occurred against a backdrop of rapid economic expansion during the pandemic recovery, low interest rates and strong company balance sheets, including elevated cash assets. Despite this growth, the Australian private equity market remains smaller than some other developed markets. Like Australia, international markets have also seen a decline in private equity activity from heightened levels during the pandemic recovery (Bain and Company 2024).

Graph 3

International Private Equity Deals

Per cent of GDP



Sources: LSEG; LSEG DataStream; RBA.

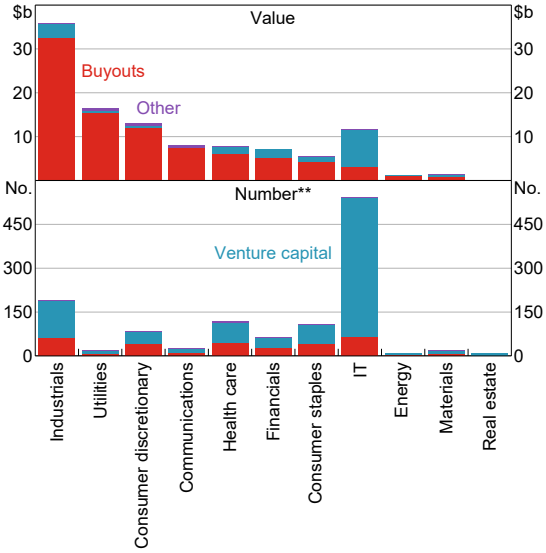
Recent private equity firm investments in Australian companies

In previous episodes of rapid growth in Australian private equity, investments were mostly concentrated in the information technology (IT) sector.[7] While the IT sector has recently attracted the greatest number of private equity deals (primarily driven by investments from venture capital firms), these deals only account for 8 per cent of the total value of private equity activity since 2020 (Graph 4). By contrast, private equity investment in other sectors have been driven by a small number of large buyouts.

Graph 4

Australian Private Equity Deals*

Since January 2020



* Data is to 31 December 2023. Values include both equity and debt components of deals involving Australian companies.

** Includes deals with undisclosed values.

Sources: LSEG; RBA.

Since the start of 2020, the value of private equity buyouts has been highest in the industrials and utilities sectors, with a relatively small value in IT companies. Industrial and utility companies often have stable cash flows and lower risk profiles. This makes them attractive targets for leveraged buyouts from private equity firms as the less volatile cash flows of the acquired company can be used to service debt. Significant deals in industrials include the approximately $25 billion acquisition of Sydney Airport and a large investment in DP World Australia ($6 billion), a prominent shipping terminal and supply chain operator. The utilities sector has also had several significant buyouts, notably AusNet ($10 billion) and Spark Infrastructure ($5 billion), both of which own and manage electrical infrastructure assets. Other notable recent buyouts include the $9 billion acquisition of Crown Resorts – the dominant transaction in the consumer discretionary sector – and the $3.5 billion deal to take telecommunications company Vocus Group private.

Unlike buyouts, the majority of recent venture capital activity in Australia has been concentrated in the IT sector. This is consistent with international venture capital investment, as developing IT companies typically have potentially strong but uncertain growth prospects that rely on high levels of initial research and development – that is, they are relatively risky investments. These companies may also remain unprofitable or generate negative cashflows for some time. To mitigate risk, venture capital firms often diversify their investments across a range of developing companies.

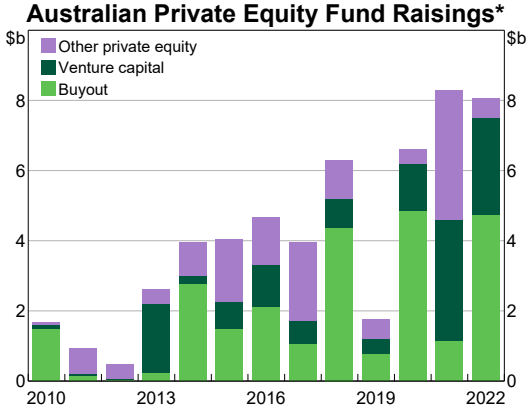
Since 2020, there have been nearly 500 venture capital deals worth a collective $8.5 billion in the Australian IT sector. This includes several later-stage funding deals for companies seeking further growth or to develop new products, such as software company Simpro ($500 million) and Canva ($450 million). The industrials sector has also seen some interest from venture capital firms, resulting in over 100 deals since 2020. The largest among these deals were concentrated on funding for companies providing technical services to support business logistics and operations.

The composition of Australian private equity fund raisings

Private equity funds based in Australia have raised significant capital in recent years (Graph 5). These funds can receive capital from both domestic and foreign investors and can invest in both domestic and foreign companies. While buyout funds generally raise the most capital, there has been a growing interest recently in venture capital and other private equity funds.

Graph 5

Australian Private Equity Fund Raisings*



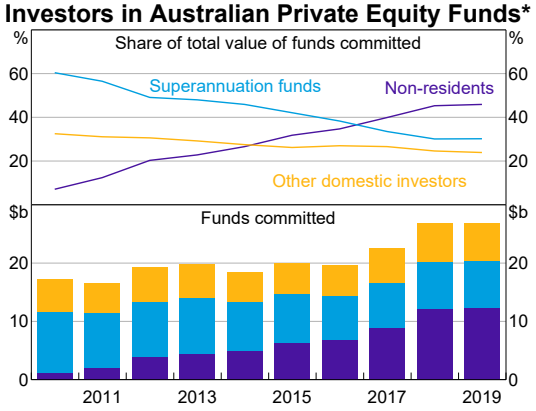
* Capital committed to Australian private equity funds from Australian and offshore investors. These funds may invest in domestic or foreign markets.

Sources: LSEG; RBA.

The share of capital committed to Australian private equity funds from foreign investors rose steadily to 45 per cent in 2019, compared with less than 10 per cent in 2010 (Graph 6). Most of this foreign capital is likely to have come from North America, though Asian investors are an increasingly large source of non-resident funding (Preqin and AIC 2024). Over this period, the Australian superannuation industry has gone from being the dominant investor class in Australian private equity to accounting for one-third of capital committed. Further, superannuation funds have reduced their exposure to unlisted equity over recent years from around 12 per cent of total assets in 2013 to 5 per cent in 2023 (APRA 2023).

Graph 6

Investors in Australian Private Equity Funds*



* Capital committed to private equity funds based in Australia.

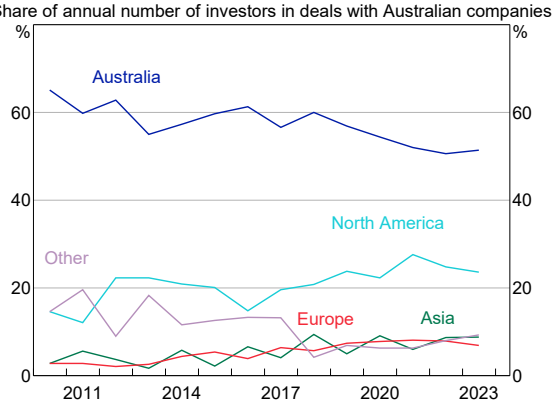
Sources: ABS; RBA.

Historically, most private equity investments in Australian companies were by Australian private equity funds investing domestic institutional money. However, offshore private equity funds have increased their Australian presence in recent years. In 2023, offshore private equity funds accounted for around 50 per cent of the total number of investments over the year, compared with around 35 per cent in 2010 (Graph 7).[8] This was primarily driven by investments from private equity funds based in the United States. Indeed, most of the largest deals in recent years (such as the acquisitions of Sydney Airport, AusNet and Crown Resorts) have had significant – if not sole – contributions from foreign private equity funds based in the United States or Canada.

Graph 7

Location of Investors in Private Equity Deals*

Share of annual number of investors in deals with Australian companies



* An investee company can receive funding from multiple private equity funds in each round.

Sources: LSEG; RBA.

The implications of a larger private equity market

There are both benefits to, and costs of, a larger private equity market. In particular, there are upside and downside risks to economic growth and capital efficiency.[9] In Australia, the private equity market remains primarily focused on smaller companies. This is despite some sizeable deals in recent years, with the level of assets under management in Australian-focused private equity funds being less than 3 per cent of listed equity market capitalisation. Further, some of the recent growth in private equity may eventually be absorbed into the public equity market.

The private equity market plays an important role in supporting the efficient allocation of capital to companies.[10] New, innovative businesses and products often seek external capital investments at a time when their growth prospects and earnings potential are highly uncertain. Venture capital firms are among the private equity firms specialised in assessing early-stage funding. Underperforming companies may also be targeted by private equity investment, which can bring expertise and experience to help maximise growth. The threat of takeover, including through buyout by private equity firms, can also discipline existing management to improve company performance.[11]

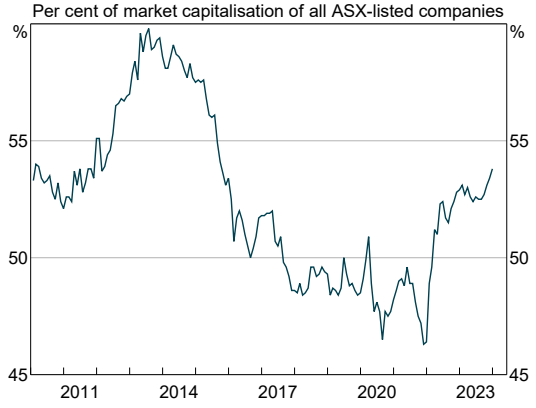
Some research, however, also indicates that the public equity market is more efficient at allocating capital than the private equity market – partly because unlisted firms are generally subject to less stringent public reporting and governance obligations.[12] Removing companies from public listing lowers transparency and may make it more difficult for investors to compare company and management performance to make informed investment decisions. Heightened levels of private equity buyout activity may reduce the diversification of the public equity market. Private buyouts of large companies have removed equity capital from the Australian public equity market at a time when there were limited inflows of new listings and initial public offerings. This has contributed to a greater concentration of the biggest companies in the public equity market,

although only to around the average of the past 14 years (Graph 8).

Graph 8

ASX20 Market Capitalisation

Per cent of market capitalisation of all ASX-listed companies



Sources: ASX; LSEG DataStream; RBA.

Conclusion

The private equity market is an important source of funding for many Australian companies, particularly for smaller or riskier businesses that have difficulty raising capital in public markets. The Australian private equity market grew over several years to 2022 before declining in 2023, mirroring a heightened period of private equity activity in other developed markets. Growth was supported by broad-based economic expansion during the pandemic recovery, historic low interest rates (which makes leveraged private equity more attractive) and other accommodative policy measures. International private equity firms and investors increased their participation in deals involving Australian companies, and Australian private equity firms sourced around half of their capital from foreign investors.

A large, competitive private equity market can contribute to promoting an innovative, efficient and dynamic business sector in Australia. This is true for both companies that receive private equity investment, and for peer companies where the possibility of a takeover can provide more discipline on existing management. However, greater private equity market size and activity could also reduce the size and diversification of the public equity market. Despite some larger deals in recent years, the Australian private equity market remains small compared with international markets. It is also much smaller than the public equity market.

Endnotes

[*] The authors completed this work in Domestic Markets Department. They would like to thank Ed Tellez and Iris Chan for their help with preparing this article. While every effort has been made to ensure the quality of the data used in this article, different data vendors may use inconsistent methodologies and some details about specific private equity transactions are undisclosed. As such, the values reported in this article should be treated as estimates.

[1] Assets under management in Australian-focused private equity funds represent only a portion of the total stock of private equity financing for Australian businesses. The value of private equity financing from other sources, such as friends, family members, and angel investors, is often undisclosed.

[2] Though some private equity investments may be in large, mature companies that are seen to be underperforming, poorly managed or undervalued.

[3] For further discussion on internal and external business finance in Australia, see Connolly and Jackman (2017).

[4] In this article, 'private equity' is used as an umbrella term that includes venture capital.

[5] The Australian private equity market encompasses both domestic and foreign private equity investments in Australian companies. Private equity firms based in Australia are discussed separately below.

[6] The scope of assets under management and fund raising data as shown in Graph 1 includes only private closed-end funds that predominantly focus on Australia, regardless of manager headquarters.

[7] For discussions on previous episodes of Australian private equity market growth, see Connolly and Tan (2002) and RBA (2007).

[8] Individual private equity deals often involve multiple private equity funds, with the value of each fund's differing contributions often undisclosed. As such, it is difficult to precisely measure the proportion of aggregate private equity deal value that is sourced from foreign private equity funds.

[9] For a broad review of academic research on the effects of private and public equity markets, see Bernstein (2022).

[10] For further discussion on the positive influence of private equity investment on economic growth and innovation, see Samila and Sorenson (2011).

[11] For more information on the positive spillover effects of private equity investments on peer companies, see Aldatmaz and Brown (2019).

[12] For further discussion on the capital allocation efficiency gap between public and private equity markets, see Sanati and Spyridopoulos (2024).

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Migration to Public Cloud: Risks and Regulatory Requirements for Clearing and Settlement Facilities

Oscar Douglas, Elizabeth Kandelas and Ed Orum[*]

Photo: Dragan Todorovic – Getty Images

Abstract

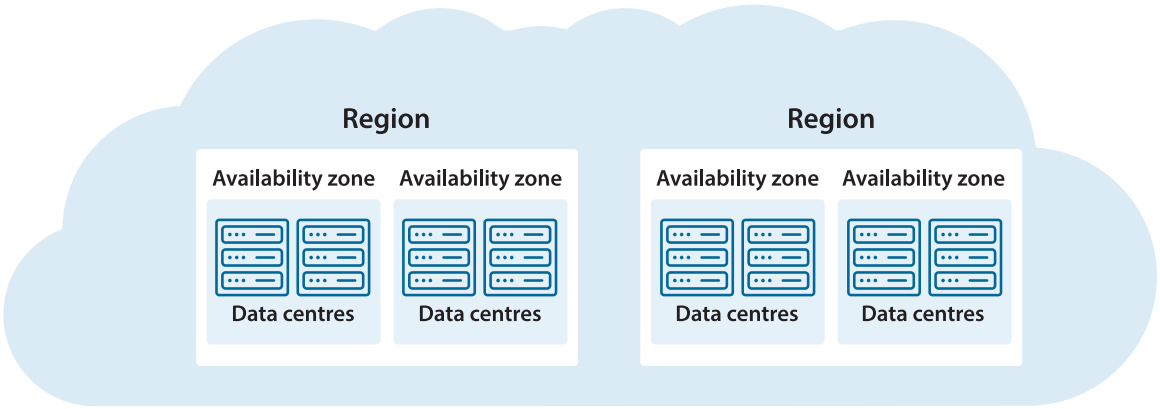
Public cloud technologies are increasingly being adopted by firms in the financial industry, including clearing and settlement facilities (CS facilities). Using public cloud offers a range of opportunities, but also presents risks for a CS facility's operations. Because CS facilities play a critical role in supporting the smooth functioning of financial markets, they need to manage these risks to ensure that they continue to provide resilient and secure services. This article discusses the opportunities and risks for CS facilities in using public cloud, and outlines the related regulatory requirements that apply to CS facilities in their management of risks, consistent with their obligations to promote efficiency and stability in the financial system.

Introduction

Adoption of public cloud is increasing among firms in the financial industry,[1] including clearing and settlement facilities (CS facilities) that are regulated by the RBA. CS facilities provide services that are critical to the operational efficiency and stability of financial markets. These services fall into two broad categories:

1. **Central counterparties (CCPs)**. These facilities act as the legal counterparty to all transactions, becoming the buyer to every seller and the seller to every buyer in the markets in which they operate. This intermediary function helps to manage the risk that buyers and sellers would otherwise face from credit exposures to each other.

Figure 1: Example of a Public Cloud Arrangement



2. **Securities settlement facilities (SSFs).** These facilities enable the final settlement of securities transactions, mitigating the risks associated with the exchange of securities and cash.

CCPs and SSFs also run a range of other services that support their clearing and settlement functions, such as facilitating securities issuances, the registration of trades, and managing collateral held by a CCP to cover certain exposures to its participants.

Operational failures that have an effect on the clearing and settlement services provided by CS facilities can significantly disrupt the functioning of financial markets. CS facilities therefore need to operate their services in a manner that is highly resilient and secure.

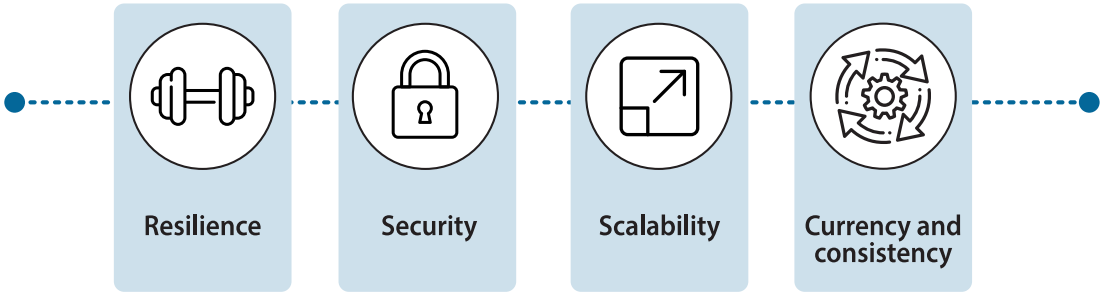
CS facilities have traditionally provided their services using on-premises data centres. Increasingly, however, CS facilities are looking to adopt public cloud technology to support the provision of these services, which are critical to the stable operation of financial markets. Using public cloud offers a number of potential benefits – including greater security, resilience and scalability – but also poses a range of risks related to cloud technology and an increased reliance on third-party providers. Before migrating services to the cloud, CS facilities need to ensure that appropriate design and testing activities are conducted. After migrating services, CS facilities need to carefully manage the services to ensure they remain resilient and secure, thereby supporting the orderly functioning of financial markets.

This article discusses some of the key opportunities and risks arising from CS facilities using public cloud and outlines the Australian regulations that require CS facilities to manage risks in a manner that supports the stability of the financial system.

What is public cloud

A public cloud is a collection of computer servers that are accessed over the internet, as well as the databases and applications that run on those servers. A public cloud is usually owned and operated by a technology company, with a common set of hardware, software and networks used to provide services to a large number of customers. Public cloud is typically hosted in numerous interconnected data centres, situated in multiple places across the world (Figure 1). Specialised software is used to optimise the use of computing resources, and to separate the data and applications of each cloud customer so that they are not visible or accessible by others (Cloudflare undated).

Figure 2: Potential Benefits of Public Cloud



Organisations may choose to use a single cloud vendor for all their needs, or different vendors for different services. They may also maintain relationships with multiple vendors as a contingency in case the services provided by their primary vendor become unavailable. There are potential benefits and risks associated with the use of public clouds, which are discussed in the following sections.

Potential benefits of CS facilities using public cloud

For CS facilities, the use of cloud technology offers several potential benefits over the use of physical data centres. If realised, the benefits outlined below could also support financial stability (Figure 2).

Resilience

CS facilities using public cloud technology can elect to have their data and applications run across multiple data centres located in different availability zones and geographical regions. The distances between these zones and regions reduces the likelihood of them all being disrupted simultaneously by physical incidents (e.g. natural disasters or power outages). This set-up provides greater resilience than traditional CS facility infrastructures, which typically comprise two or three data centres that may be situated close to each other (e.g. in the same city). Public cloud can help reduce the risk of a single point of failure and support higher availability than traditional data centres.

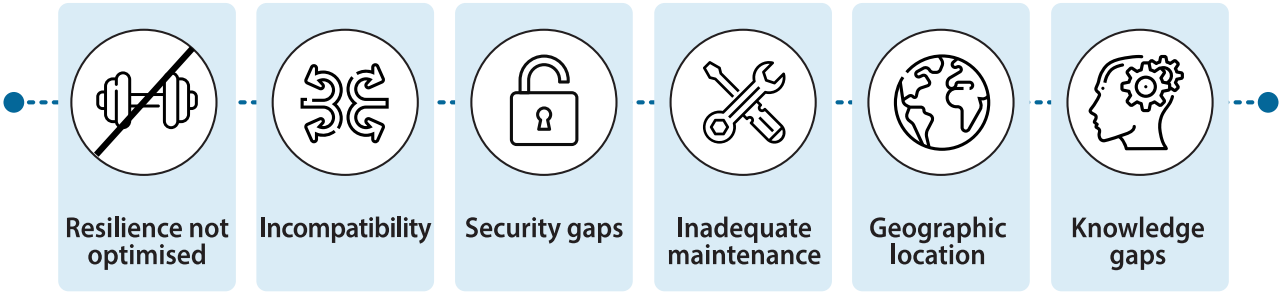
Security

Public cloud services can provide enhanced security solutions to protect against the loss or compromise of data and disruption to operations due to malicious activities such as cyber-attacks. The resourcing, specialisation and economies of scale of third-party providers enables them to develop and maintain security features that keep abreast of best practice and evolving security threats in a way that may not be possible for individual CS facilities. They also have the capacity to keep their infrastructure up to date and patch any security vulnerabilities as soon as possible.

Scalability

Public cloud environments provide vast potential amounts of computing power, due to the large scale of available resources and the technologies used to optimise the use of those resources. CS facilities can purchase access to additional computing power on-demand when using public cloud. This allows CS facilities to increase their processing capacity quickly and easily as required – for example, to respond to a significant market event that leads to substantial growth in transaction

Figure 3: Public Cloud Risks related to Technology



volumes. In contrast, capacity in traditional data centres is limited by the resources owned by the CS facility and scaling up requires significant planning and capital expenditure (US Department of the Treasury 2023).

Currency and consistency of infrastructure

Public cloud provides common sets of technology infrastructure and tools that are kept up to date by the cloud provider. Migrating systems from traditional data centres onto public cloud platforms alleviates the need for CS facilities to update many infrastructure components in physical data centres. It also provides opportunities for CS facilities to consolidate disparate legacy infrastructures and systems, thereby simplifying and standardising their technology environments.

Risks of migrating to and operating critical services in public cloud

While public cloud technology offers potential advantages over traditional data centres, migrating to and operating critical services in the cloud also poses a range of risks (Koh and Prenio 2023). CS facilities need to:

- identify and assess these risks in detail
- put in place and regularly assess the effectiveness of controls to mitigate the risks, to ensure that their critical services continue to support the stability of the financial markets they serve.

Some of the key technology and outsourcing risks associated with using public cloud are outlined in the following sections.

Technology-related risks

Transitioning from an on-premises operating model to a public cloud-based operating model is a significant and complex technology transformation. While there are broader change management risks associated with adopting, and operating in any new technology environment (e.g. introducing a new system), there are additional risks that are specific to the use of public cloud. The additional risks that CS facilities should consider are outlined below (Figure 3).

Resilience not optimised

While public cloud can offer benefits to resilience and reliability, realising these benefits requires proactive planning, design and investment by the CS facility. A CS facility without a well-defined cloud strategy and resilience objectives is unlikely to fully realise the benefits and appropriately manage the risks of public cloud. For example, if a CS facility pursues cost savings over resilience, it may make design choices that do not take advantage of the capabilities of public cloud, such as locating data centres in multiple availability zones and regions.

This could result in the CS facility's public cloud environment being no more resilient (or even becoming less resilient) than its existing on-premises environment.

Additionally, applications running in public cloud need to be designed to take advantage of its resilience features. A 'lift and shift' approach of moving existing applications to the cloud without appropriate redesign and testing is unlikely to result in the realisation of the resilience opportunities of cloud (O 2023; Pekkarinen undated). For example, legacy applications may not be able to operate effectively across multiple availability zones.

Resilience risks would also arise from CS facilities underinvesting in business continuity arrangements for their critical services in a public cloud environment. While extended outages that affect multiple cloud availability zones and regions are rare, they could still occur. If a CS facility operates multiple critical systems in a public cloud, all of these systems could be disrupted simultaneously. CS facilities that have not understood and tested the outage response arrangements of their public cloud providers, and do not have complementary business continuity plans, risk being unable to resume operation in a timely manner.

Incompatibility with on-premises systems

Without appropriate design and testing, CS facilities risk their public cloud-based services being incompatible with related systems that remain in their on-premises environment. This risk can be particularly prevalent during a CS facility's transition to a public cloud. It is important that CS facilities understand how their technologies will interact throughout all of the transition stages to avoid operational incidents and service unavailability.

Security gaps

While public cloud vendors can provide enhanced baseline security arrangements, CS facilities have a significant role to play in protecting their own services running in a public cloud. CS facilities need to build and configure their systems in a way that is compatible with, and takes advantage of, the vendor's security features. They are also responsible for implementing security controls and applying security patches to their applications, to protect their services within the cloud from hostile actors, including malicious insiders. A CS facility that fails to understand and fulfil its role in ensuring the security of its public cloud operations, or misconfigures security settings, could leave its critical services exposed to inadvertent, hostile or malicious compromise. Misconfiguration by cloud users has been reported as the most common source of data breaches in the cloud (US Department of the Treasury 2023).

Additionally, taking a 'lift and shift' strategy to migrating legacy applications can affect security, because it can result in on-premises security vulnerabilities being transferred to the public cloud (Pekkarinen undated). In practice, CS facilities would need to apply the same level of cyber-risk analysis and monitoring to the cloud-based systems, as they would for on-premises solutions.

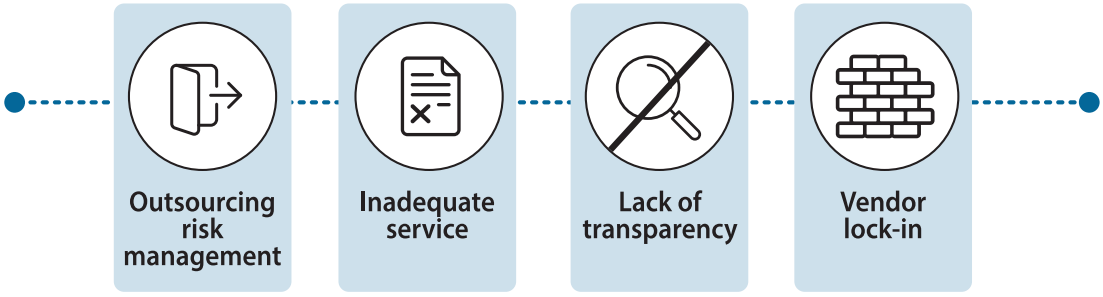
Inadequate maintenance

Once established, cloud-based systems need to continue to be updated and tested for security and resilience. Public cloud environments are continually evolving, for example, in response to emerging security threats or changes required by their customers. If a CS facility fails to maintain cloud-based systems in line with the cloud provider's upgrade schedule, this could create gaps and incompatibilities that pose a risk to the security and reliability of critical services.

Geographic location of data

Duplication of data across geographically diverse cloud locations can support resilience. However, if a CS facility chooses to use a cloud region located in another jurisdiction, it may be exposed to the legal or regulatory systems of that jurisdiction. Some governments place ownership and access restrictions on data held within their jurisdiction, which could limit a CS facility's control over its own data and systems. Issues with accessing data could be exacerbated by national crisis measures such as those taken by some jurisdictions during the COVID-19 pandemic.

Figure 4: Public Cloud Risks related to Outsourcing to Third-party Vendors



Insufficient cloud knowledge

The migration and operation of services in a public cloud requires staff at CS facilities to have different technical skills and operating mindsets to the skills associated with operating and maintaining on-premises systems. Similarly, a CS facility's board of directors and management need sufficient understanding of public cloud to provide effective oversight and governance for cloud migrations and operations. As with all technologies, insufficient cloud skills at the staff, management and board levels could lead to poor design decisions and sub-optimal operational, resilience and security outcomes.

Risks relating to outsourcing services to a third party

CS facilities typically use the technology products and services of a variety of third-party vendors in delivering their critical services. However, moving these critical services to operate in a public cloud significantly increases a CS facility's reliance on a single external provider, which heightens vendor-related risks as outlined below (Figure 4).

Outsourcing the management of risks

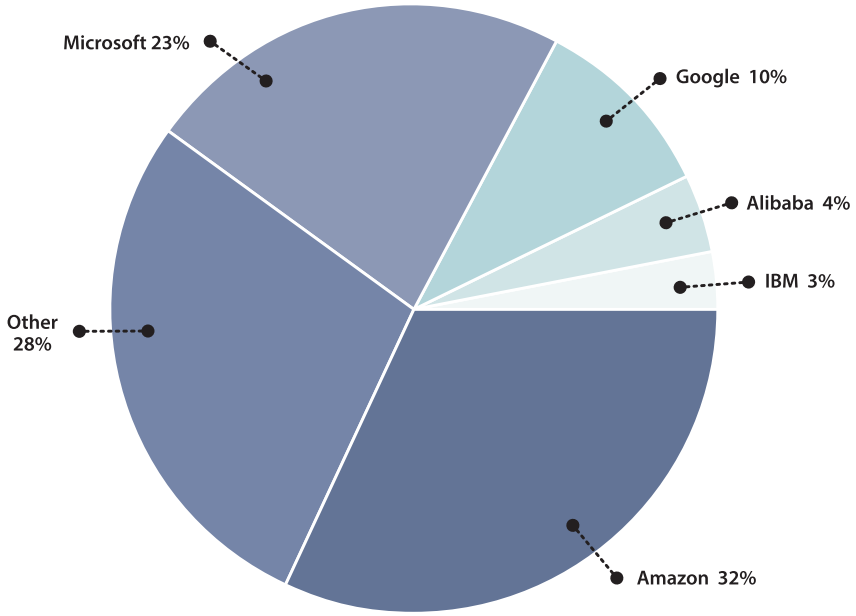
Public cloud providers might not manage risks in a manner appropriate to the operation of critical market infrastructure. The stability of a CS facility's critical services can be compromised if it does not validate the sufficiency of a vendor's risk management practices, or if it leaves risk management entirely to the third party. There are also technology-related risks that can only be managed by the CS facility itself, and not by the provider.

Inadequate levels of service

Although public cloud infrastructure can support high availability, resilience and security, there remains a risk that the public cloud provider fails to deliver a level of service commensurate with the criticality of a CS facility's services. This could occur for a variety of reasons. For example:

- The public cloud provider may not meet appropriate levels of availability, resilience and security set out in contractual arrangements. For instance, in the event of an operational disruption, the provider may not respond with sufficient urgency to restore services used by the CS facility.
- There may be deficiencies in the contractual service agreement. Public cloud providers have significant market power and may not agree to contractual arrangements that meet the needs of CS facilities.

Figure 5: Share of Infrastructure and Platform Cloud Services in 2023



Source: Synergy Research Group.

Lack of transparency

CS facilities may have limited visibility of the public cloud provider's operations, security arrangements and potential points of failure. This can make it difficult for a CS facility to determine if the cloud provider is delivering a reliable, secure and resilient service. Transparency may be further reduced where the cloud provider sub-contracts parts of its operations to fourth-party vendors.

Vendor lock-in

If the public cloud provider is no longer able to deliver an appropriate service (e.g. if the provider becomes insolvent), a CS facility may need to exit the arrangement. This exit could mean the CS facility needs to migrate its services to a different provider or bring the services back on premises. A CS facility's critical services could be severely disrupted if it does not have an effective plan and sufficient funding to exit and transition from its cloud provider.

Concentration risks

The public cloud market is dominated by Amazon Web Services, Microsoft Azure, and Google Cloud. Together, these providers accounted for almost two-thirds of the world market for cloud infrastructure and platform services in 2023 (Saarinen 2023) (Figure 5).

The limited number of public cloud providers means that many CS facilities, as well as their participants and clients, are also likely to be reliant on services from the same providers. This concentration means that an outage at a service provider could cause widespread disruption to the financial system. This issue is broader than CS facilities – concentration risk affects the whole financial industry, as well as other sectors, and has attracted increasing attention by regulators in Australia and internationally.

Regulations requiring CS facilities to manage risks posed by cloud

CS facilities are required to comply with the Financial Stability Standards (FSS) set by the RBA (RBA 2012a; RBA 2012b). These standards are based on the CPMI-IOSCO Principles for Financial Market Infrastructures, and are designed to ensure that CS facilities conduct their affairs in a manner that is consistent with financial stability.[2] The RBA assesses CS facilities against the FSS on a regular basis.

The FSS require CS facilities to identify the operational risks (including technology and third-party risks) to their critical services, and manage these risks in a manner that supports the stability of the financial system. The requirements apply equally to a CS facility's use of public cloud and traditional technologies, and provide a framework for ensuring that operational risks are addressed appropriately.

CS facilities are required to have in place robust systems, policies, procedures and controls to monitor and mitigate sources of operational risk. To meet the FSS requirements in the context of using public cloud, CS facilities must develop a thorough and detailed understanding of the potential risks, including to resilience and security. They also need to address these risks through the design, migration and subsequent operation of their cloud solutions.

Management of technology risks

The FSS require CS facilities to design the technology systems supporting critical services to be highly resilient and secure. CS facilities are also required to have the following:

- **Availability targets.** CS facilities must set clear and exacting targets for the reliability and availability of their critical systems.
- **Business continuity and recovery arrangements.** CS facilities must have arrangements in place to ensure that critical operations can resume within two hours following an operational or security disruption, and by no later than the end of the day, even in extreme circumstances. Systems should be able to resume with a high degree of confidence that data has not been lost.
- **Security.** CS facilities must implement safeguards to defend against current and potential future threats to the security of their systems and data (e.g. cyber-attacks). These controls should be regularly updated and tested to ensure their ongoing effectiveness.
- **Access to skilled resources.** CS facilities must have access to staff with appropriate skills to ensure that their critical services operate reliably and securely in all circumstances.

Management of third-party vendor risks

CS facilities that outsource key systems to third-party cloud vendors ultimately remain responsible for ensuring that their services meet the resilience and security requirements of the FSS. CS facilities are required to have the following:

- **Formal outsourcing policies.** These policies should include robust arrangements for selecting and monitoring vendors (including cloud providers) to ensure that the services provided meet all regulatory requirements. The FSS contain guidance on the scrutiny CS facilities should exercise over the risk management processes of third-party providers, particularly in relation to service availability, business continuity and recovery, and the confidentiality and integrity of data.
- **Access to information.** Contractual arrangements with vendors must provide CS facilities access to the information needed to assess the vendor's performance. Access to information must similarly be provided to the RBA. Contractual arrangements with vendors also must provide CS facilities with information about, and control over, the use of sub-contractors.
- **Formal policies for exiting outsourcing arrangements.** Exit arrangements (such as those relating to exiting a cloud provider) must ensure the continuity of critical services even in the event of a crisis.

The FSS do not directly address risks posed by the concentration of cloud vendors. However, management of technology and third-party risks in accordance with the FSS helps to ensure that CS facilities are more resilient to issues with their cloud providers. CS facility participants are also typically subject to prudential regulations that require them to manage third-party risks.

Governance

The FSS recognise the importance of sound board oversight and senior management leadership in managing operational risks. A CS facility's board of directors and management must have appropriate skills to discharge these responsibilities. For a CS facility looking to use cloud technologies, this would include skills to oversee and manage the risks associated with migrating to and operating critical systems in a public cloud. The FSS also set out specific governance responsibilities for a CS facility's board and board committees, including in relation to the approval of third-party outsourcing arrangements and receiving regular reporting on the performance of critical services.

Conclusion

CS facilities play a critical role in ensuring the stability and effectiveness of the financial system. The adoption of public cloud provides opportunities for CS facilities to enhance the technologies they use to deliver their critical services. However, there are also notable risks with migrating to and operating in a public cloud, relating to the appropriate and competent use of the technology, and to increased reliance on third-party vendors. The FSS require CS facilities to carefully identify and appropriately manage these risks so that critical services that are housed in a public cloud environment operate in a manner that is consistent with financial stability.

Endnotes

[*] The authors are from Payments Policy Department. This article draws on information from the following sources: APRA (2018), AWS (2023), CBA (undated), Crozier (2023), IBM (undated), Microsoft (undated), NAB (2022), O (2023), Perry (2020), Pekkarinen (undated), Saarinen (2023) and Westpac (2017). The authors would like to thank Benn Robertson, John Kenyon and James Macnaughton for their insight and input into this article.

[1] For example, the major Australian banks are pursuing technology strategies to migrate services progressively to cloud environments, with some banks now using cloud to run more than 70 per cent of their applications (CBA undated); (NAB 2022). Some newer neobanks are almost entirely cloud-based.

[2] In interpreting relevant requirements under the FSS, the RBA also applies the guidance on cyber resilience for financial market infrastructures from CPMI-IOSCO (2016).

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China's Monetary Policy Framework and Financial Market Transmission

William Maher[*]

Photo: Jackal Pan – Getty Images

Abstract

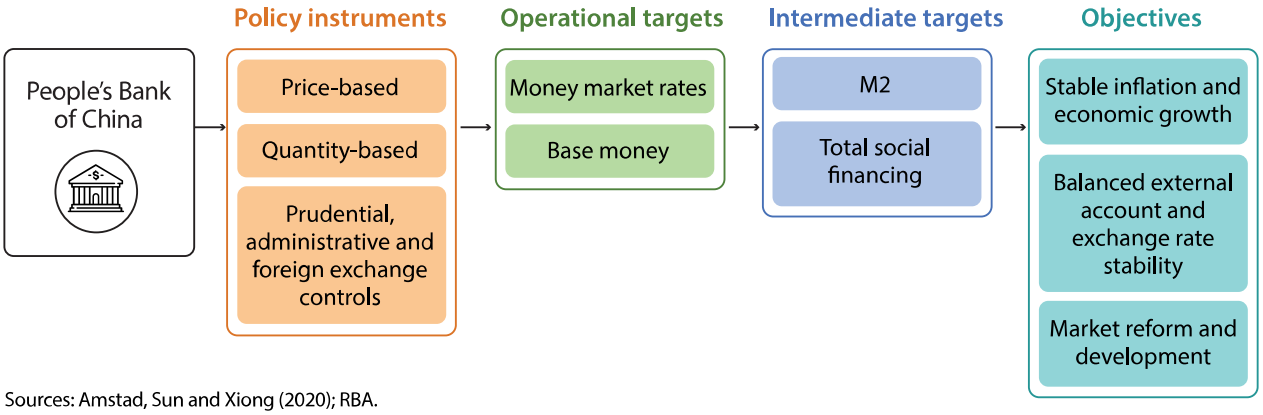
While it has evolved significantly over the years, China's monetary policy framework continues to differ in some important respects to those in most advanced economies. In contrast to these economies, the People's Bank of China makes significant use of quantity-based policy instruments, though interest rates now play a greater role than in the past. This article takes stock of China's current monetary policy framework and its implementation, and discusses the transmission of price-based monetary policy instruments to market and retail interest rates in the economy. In doing so, this article sheds light on the implementation of monetary policy in the world's second largest economy.

Introduction

China's central bank, the People's Bank of China (PBC), was established in 1948. Since the PBC's inception, China's monetary policy framework has changed significantly, including over the past decade or so. The monetary policy framework was initially built on central credit planning, where long-term credit was allocated to projects selected by national and local governments. Central credit planning then gave way to a period of direct credit control between 1979 and 1997, where the PBC selected bank credit as its main intermediate policy target (Jones and Bowman 2019).

In 1995, the *Law of the People's Republic of China on the People's Bank of China* commenced, which outlines the PBC's responsibilities under the

Figure 1: China's Monetary Policy Framework



Sources: Amstad, Sun and Xiong (2020); RBA.

leadership of the State Council (China's primary administrative authority). These responsibilities are:

- to make and implement monetary policy
- to prevent and resolve financial risks
- to maintain financial stability (PBC 2003).

Shortly after, in 1998, the PBC abolished direct controls over bank credit and moved to indirect control of money and credit.

The PBC is obligated to support the objectives of the State Council, one consequence of which is that monetary policy is often used to complement fiscal policies, with operational independence restricted to the more technical aspects of monetary policy implementation. China's capital account settings also have implications for monetary policy. While gradual progress has been made on liberalising capital flows, China maintains restrictions on its capital account alongside a managed float exchange rate. Consequently, authorities face the common 'trilemma' of managing the trade-off between autonomous monetary policy, stability of the exchange rate and the degree to which capital is allowed to freely flow in and out of China. Thus, the PBC is more constrained in its use of price- and quantity-based instruments than is typical of the central banks of most advanced economies. This article discusses these instruments, their implementation and China's monetary policy framework more broadly.

The current monetary policy framework

With interest rate liberalisation now more advanced, interest rates have come to play a greater role in China's monetary policy framework (Yi 2021). However, given the PBC's wider set of objectives, the PBC still uses quantity-based tools extensively and also relies on prudential and administrative controls, and exchange rate management to influence its operational targets (Figure 1).

Objectives of monetary policy

The ultimate objective of the PBC is 'to maintain the stability of the value of the currency and thereby promote economic growth' (PBC 2022a). The PBC interprets stability of the currency in two ways: domestically, it means maintaining price stability – that is, inflation; externally, it means keeping the exchange rate at an 'adaptive and equilibrium level' (Yi 2018). However, the PBC has indicated it has other core objectives (economic growth, full employment, and broadly maintaining balance of payments) and two dynamic objectives (financial reform and financial market development). The maintenance of multiple objectives implies a trade-off, with the PBC having previously stated that the weight placed on any given objective can vary based on how it deviates from the PBC's targets (Zhou 2016).

Intermediate monetary policy targets

The PBC's intermediate targets – that is, those the central bank can significantly influence with a reasonable time lag – are broad money supply (M2) and aggregate financing to the real economy, also referred to as total social financing (TSF). Following the abolition of the mandatory credit plan in 1998, M2 and bank credit became the two most important intermediate targets for monetary policy. However, as the correlation between M2 and economic activity declined, the PBC adopted TSF as an additional intermediate target in 2012 (Yi 2018). Specific numerical targets for M2 growth have not been set since 2018, though the PBC has continued to communicate that growth in M2 and TSF should be aligned with nominal economic growth (Sun 2021; Keqiang 2023).

Over time, the exchange rate has also appeared to serve as both a monetary policy objective and intermediate target (Jones and Bowman 2019). While authorities often note that the renminbi exchange rate is determined by market forces, in practice they maintain a managed float. Authorities retain significant influence over the exchange rate via the daily Chinese yuan fix – the midpoint of the permitted ±2 per cent daily trading range – as well as the use of other measures. These measures have included capital flow management measures such as adjustments to risk reserve requirements for foreign exchange forwards and adjustments to cross-border financing macroprudential policies. In recent history, exchange rate management has been most evident during periods of rapid and sustained movements in the currency.

Operational targets

To achieve its intermediate targets, the PBC uses a hybrid operating target system that includes influencing both the monetary base (currency and banking institutions' deposits with the PBC) and short-term repurchase (repo) rates. The PBC has targeted the seven-day interbank repo rate as the de facto operational target since around 2017, as this instrument involves large trading volumes and is closely correlated with other short- and medium-term market interest rates.

Policy instruments

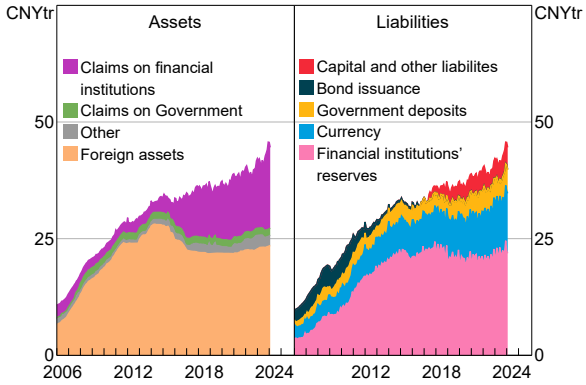
While the PBC has indicated a desire to transition from quantity to price controls, price-based instruments have complemented quantity-based instruments, rather than operating as primary policy instruments. Indeed, the use of policy rates has become smaller and less frequent in recent years, which may reflect a desire for greater control of credit growth (Yi 2018; Amstad, Sun and Xiong 2020; IMF 2023).

Quantity-based instruments

The PBC can adjust either side of its balance sheet to affect its intermediate targets (Graph 1). On the liability side, the PBC can adjust reserve balances (or issue debt); on the asset side, the PBC can buy or sell assets, such as foreign exchange, or lend to domestic banks and the government (Table 1). The PBC can use these tools to influence both base money and benchmark rates, like the seven-day repo rate, discussed below.

Graph 1

PBC Balance Sheet



Sources: CEIC Data; RBA.

One of the PBC's more frequently used quantitative instruments is the reserve requirement ratio (RRR). The PBC generally uses adjustments to the RRR to manage the monetary base, adjusting liquidity conditions for financial institutions, rather than for financial stability reasons. Despite the RRR historically being used as a liquidity management tool to offset the flows of foreign exchange reserves in China, more recent use of the RRR has been highly correlated with easing in the PBC's price-based instruments, and still carries a strong signalling effect for monetary policy.

Table 1: The PBC's Quantity-based Instruments

Tool	Description
Reserve requirement ratio	The share of deposits a bank must hold as required reserves with the PBC.
Open market operations	Primarily repurchase (and reverse repurchase) agreements used by the PBC to affect interbank funding conditions.
Liquidity facilities[(a)]	Facilities used to support funding conditions and, in some instances, to provide targeted support to sectors.
Relending facilities	Facilities typically offering shorter term funding (less than one year) to banks, secured by high-quality collateral and targeted at specific sectors.
Rediscounting	The PBC purchases (discounts) unexpired discounted commercial bills of exchange held by financial institutions.

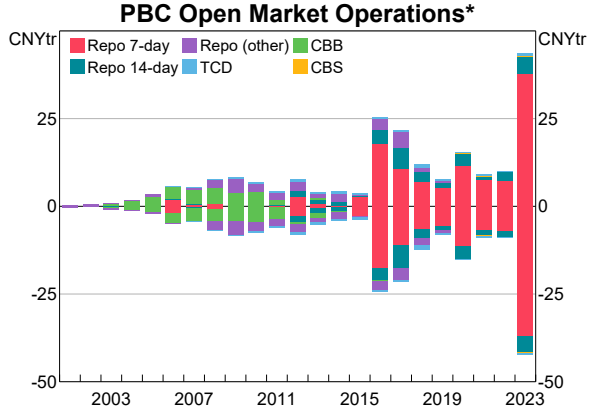
(a) See Table A1 in Appendix A for a summary of the PBC's liquidity provisioning.

Sources: PBC (2010); PBC (2014); PBC (2022b); RBA.

In addition to the RRR, the PBC uses regular open market operations (OMO) to manage interbank liquidity. These are primarily repo (and reverse repo) agreements (Graph 2).[1] Repo maturities range from one week to one year (though the most common are seven-day), and they are secured against high-quality collateral, like government and policy-bank bonds.

Graph 2

PBC Open Market Operations*



* Includes: central bank bills (CBB), central bank bills swap (CBS), repurchase and reverse repurchase agreements (repos); and Treasury cash deposits (TCD).

Sources: RBA; WIND.

Outside of OMO activity, the PBC has a range of facilities to manage liquidity in the banking system (see Table A1 in Appendix A). The most heavily used is the medium-term lending facility (MLF). The MLF was introduced in 2014 and provides medium-term (typically one year) funding to commercial and policy banks, with participants pledging high-quality collateral (such as Treasury bonds, central bank bills and high-grade bonds). Notably, the interest rate on MLF funds is the PBC's medium-term policy rate; since 2017 the PBC has only issued funds at a 12-month tenor. In the past, facilities like the pledged supplementary lending facility have also been used to provide longer term funding to support government infrastructure projects.

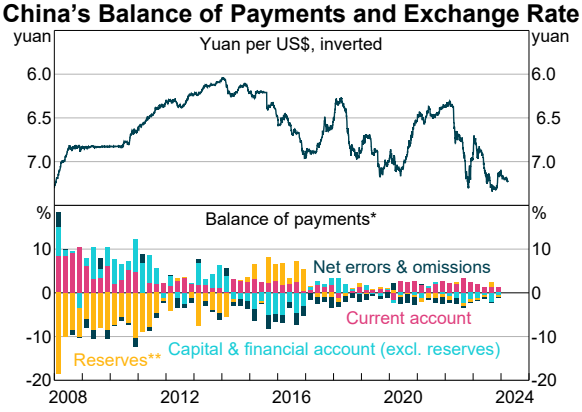
The PBC can also use 'structural' monetary policy tools. These refer to the PBC's relending and rediscounting facilities. Relending facilities consist of shorter term funding (less than one year) to banks, secured by high-quality bank loans or high-grade bonds. Relending facilities generally provide cheaper funding to banks when compared with other facilities, such as the MLF, and are primarily used to support specific industries. The PBC typically adopts a 'reimbursement' mechanism, whereby financial institutions make loans to eligible projects at a rate close to the loan prime rate (LPR; discussed below) or lower if the borrower's credit rating permits, and are then reimbursed by the PBC at the rate on the relending facility (PBC 2022d). The PBC's rediscounting program refers to the purchase of unexpired discounted commercial bills of exchange held by financial institutions to channel funds to banks, typically to support financing to specific sectors.

Movements in foreign exchange reserves are closely related to China's base money supply management and have a significant impact on the use of various monetary policy instruments (Amstad, Sun and Xiong 2020). When the PBC accumulates foreign currency reserves, as it did for the period between 2002 and 2014, the PBC credits banks' reserve balances with domestic currency, which increases

liquidity (Graph 3). If these increases are considered inconsistent with the PBC's objectives, they have typically been offset through either OMO or increases in the RRR – which, along with the PBC's liquidity facilities, forms its toolbox for managing liquidity.

Graph 3

China's Balance of Payments and Exchange Rate



* Per cent of GDP.
** Positive number indicates sale of reserves.
Sources: CEIC Data; RBA.

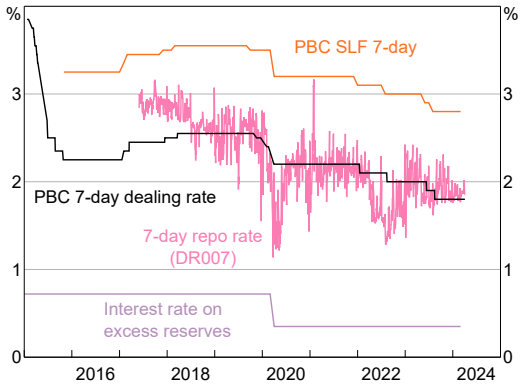
Price-based instruments

The PBC operates an interest rate corridor to guide its short-term policy rate (Graph 4). The short-term policy rate is the PBC seven-day reverse repo rate used in OMO. Through daily OMO, the PBC influences short-term rates (its operational targets), such as the pledged seven-day repo rate for participating banks and other eligible financial institutions. The corridor ceiling is the rate on the standing lending facility (SLF) – the rate at which the PBC will provide short-term funding to financial institutions – set at 100 basis points above the PBC seven-day reverse repo rate. The floor is the interest rate at which the PBC remunerates banks' excess reserves – currently 145 basis points below the seven-day repo rate.

The PBC's medium-term policy rate is the rate on the MLF. Benchmark deposit rates (discussed below) may also be considered one of the PBC's price-based instruments, though they are used less frequently than the PBC's other price-based and quantity-based tools.

Graph 4

PBC Interest Rate Corridor



Sources: CEIC Data; RBA.

Prudential and administrative controls

Along with price- and quantity-based tools, the PBC also uses a range of prudential and administrative tools to achieve its objectives, including window guidance and the macroprudential assessment framework (MPA). The term 'window guidance' refers to central bank actions to influence commercial banks' behaviour, typically without official acknowledgement. Recent reported examples include the PBC asking banks to purchase Chinese local government financing vehicles' debt instruments in late 2022, and advising some banks to slow the pace of lending in early 2023 (Bergman 2022; Reuters 2023).

At the beginning of 2016, the PBC introduced the MPA framework to help address macroprudential risks in the financial system. The framework uses a scoring system (0–100) for 16 indicators across seven categories to assess the soundness of banking institutions and their compliance with national directives (Jones and Bowman 2019). The MPA aims to influence each bank's loan and other credit expansion with the use of differentiated reserve requirements and remuneration on the reserves of that bank (Amstad, Sun and Xiong 2020).

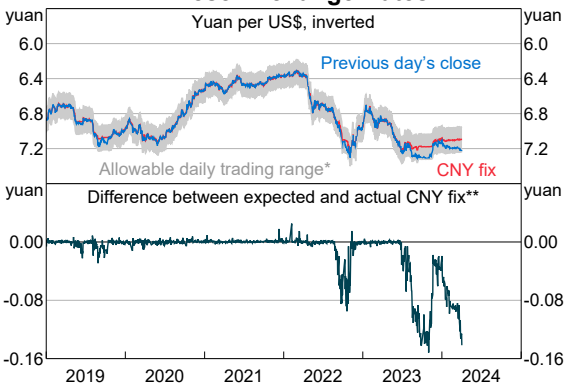
The PBC also uses other prudential tools to support monetary policy, including policies aimed at directly influencing its intermediate targets. Recent examples include an adjustment to the macroprudential parameter that controls the quantity of cross-border financing for companies (including banks), and adjustments to mortgage rate floors (PBC 2022c).

Foreign exchange management

To achieve its monetary policy objective of keeping the renminbi exchange rate at an 'adaptive and equilibrium level', the PBC intervenes directly in the foreign exchange market and also uses a range of indirect measures. Foreign exchange intervention has become less frequent since 2016. More recently, former PBC Governor, Yi Gang, noted that the PBC has largely exited from regular intervention, though it reserves the right to intervene in extreme situations (Yi 2023). However, over the past couple of years the PBC has used the CNY fix and other indirect measures to support the exchange rate, suggesting intervention remains a tool the PBC is willing to use, albeit less frequently (Graph 5).

Graph 5

Chinese Exchange Rates



* Since early 2014 the CNY has been allowed to trade in a daily range of +/- 2 per cent from the CNY fix.

** Negative values indicate the official fix was stronger than expected by market economists, supporting the yuan against the US dollar.

Sources: Bloomberg; CEIC Data; RBA.

Transmission of Chinese monetary policy price-based instruments

Policy rate transmission to benchmark rates

The PBC influences the short-end of the yield curve through short- and medium-term interbank liquidity operations, the MLF rate and adjustments to the interest rate corridor. These operations influence the PBC's short-term benchmark rate (the seven-day repo rate for participating depository institutions or 'DR007'), which is closely monitored as an indicator of market liquidity (Graph 4; Figure 2).

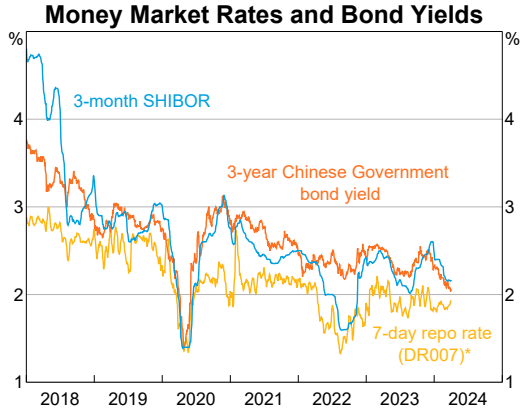
Adjustments to the PBC's MLF rate directly influence LPRs (Figure 2).[2] LPRs are a benchmark that represents the average interest rate on loans that commercial banks provide to their most creditworthy customers, and are the major pricing reference for financial institutions (Yi 2021). LPRs are quoted as a spread to the MLF, with the spread reflecting the cost of funds, risk premium and other factors. So, for example, when the PBC lowers the MLF, there is typically a subsequent decline in the LPR (though movements in the LPR need not necessarily be preceded by a movement in the MLF). Other factors can also affect the spread between the LPR and the MLF – for example, if there was a notable change in credit risk associated with lending to banks' best customers, a change in the MLF may not completely flow through to a change in the LPR.

Transmission to market rates

Policy-induced changes to liquidity conditions in the interbank system influence money market rates (such as the Shanghai interbank offered rate, or SHIBOR) and, to some extent, movements in the short-end of the Chinese Government bond yield curve (Graph 6). Yields on medium- and long-term government debt have a loose relationship with money markets, though they are more heavily influenced by market expectations of the development of the macroeconomy and the stance of monetary policy (Yi 2021).

Graph 6

Money Market Rates and Bond Yields



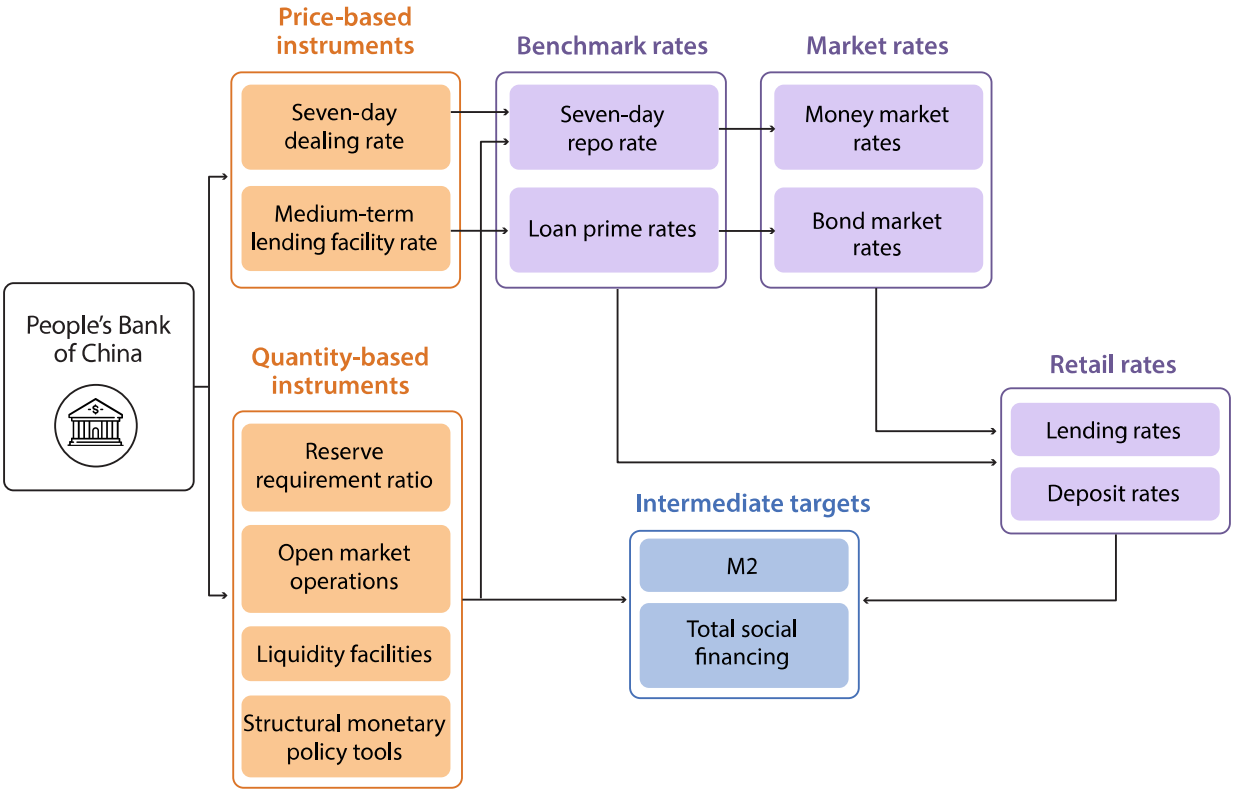
* 10-day moving average.

Sources: CEIC Data; RBA.

Retail lending and deposit rates

Since 2019, all new bank loans have been priced relative to the LPR, improving the transmission of changes in the MLF through to lending rates.[3] While banks use an appropriate LPR as a reference rate for borrowers depending on the maturity of the

Figure 2: China's Interest Rate Structure



Sources: Yi (2021); RBA.

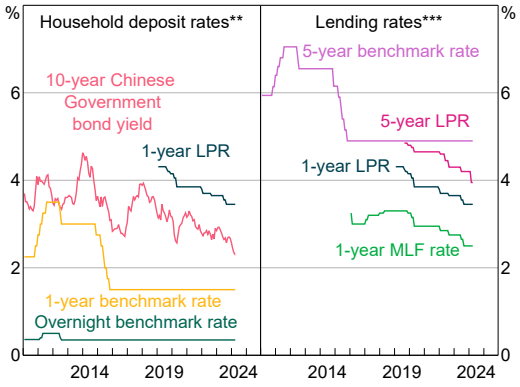
loan, the PBC determines a mortgage rate floor. Longer term loans to households, which largely consist of mortgages, are typically priced off the five-year LPR. For loans with maturities of less than five years, financial institutions are free to choose the relevant LPR.

The PBC's mortgage rate floor for first home buyers is currently 20 basis points below the five-year LPR. For other borrowers, the mortgage rate floor is 20 basis points above the five-year LPR. In an effort to support the demand for housing amid the weakness in the property sector over 2022, the PBC and the China Banking and Insurance Regulatory Commission allowed banks to provide first home buyers with mortgage rates below the PBC floor in cities that experienced three consecutive months of new housing price declines (PBC 2022e). Further measures announced in 2023 included refinancing of outstanding mortgages, guidance to lend to some sectors of the economy, and lower limits on mortgage rates on second homes (PBC 2023). These measures have likely contributed to pressure on banks' profitability, as lending rates have declined further than deposit rates.

The LPR also has influence over bank deposit rates. Banks are given 'flexible' guidance to set deposit rates based on movements in the 10-year Chinese government bond yield and the one-year LPR. In practice, the one-year LPR has the most influence since most fixed-term deposits have a maturity of less than two years. This means the MLF rate exerts influence over both deposit and lending rates, though over the past few years adjustments in deposit rates have been slower – likely reflecting the importance of deposits in Chinese banks' funding structures. Deposit rates are also subject to an upper limit, which is determined by a regulatory body – the Interest Rate Self-discipline Mechanism – composed of financial institutions and overseen by the PBC. The one-year upper limit on demand deposits is currently set at 10 and 20 basis points above the PBC's benchmark deposit rate for large, and small and medium banks, respectively (Graph 7).

Graph 7

Benchmark Interest Rates*



* Values as at last trading day of month.

** From April 2022 the PBC has guided banks to set deposit rates with reference to the one-year LPR and 10-year Chinese Government bond yield.

*** In August 2019, it was announced that Loan Prime Rates (LPR) would become the new reference rates for lending.

Sources: CEIC Data; RBA.

Conclusion

China's monetary policy framework has evolved considerably over the past few decades to involve the greater use of price-based instruments. The PBC's primary price-based instruments – the seven-day repo rate, and the rate on the MLF – influence broader market rates in the economy, ultimately affecting retail rates. Nevertheless, the PBC's prudential and administrative, and quantity-based instruments continue to play a more central role in China than elsewhere, with adjustments to the RRR and structural monetary policy tools continuing to be commonplace in China's monetary policy framework.

Appendix A: Liquidity facilities

Table A1: Overview of China's Liquidity Provisioning Facilities

Facility	Time of introduction	Purpose	Target banks	Tenor	Collateral required
Standing lending facility (SLF)	Early 2013	To meet unusually large liquidity demand	All banks	1 day – 1 month	High-quality bonds and credit assets
Pledged supplementary lending facility (PSL)	April 2014	A collateralised form of on-lending facility	Policy banks	Normally >3 years	Adjustable by the PBC
Medium-term lending facility (MLF)	September 2014	To supply base money over the medium term	Qualified commercial banks and policy banks	3–12 months	High-quality bonds
Targeted medium-term lending facility (TMLF)	December 2018	To supply base money over the medium term to provide liquidity to the private sector	Qualified commercial banks and policy banks	3 years (12 months can be rolled over on request)	High-quality bonds
Temporary lending facility (TLF)	January 2017	Temporary supply of base money	Five biggest state-owned commercial banks	28 days	No collateral required
Contingent reserve arrangement (CRA)	January 2018	Temporary supply of base money	National commercial banks	30 days	No collateral required

Sources: Amstad, Sun and Xiong (2020); RBA.

Endnotes

[*] The author wrote this article while in the International Department. The author is grateful for comments provided by Brad Jones, Penny Smith, Jeremy Lawson, Jarkko Jaaskela, John Boulter, Kassim Durrani, Morgan Spearritt and Patrick Hendy.

[1] The PBC's shift to repo use in its OMO activity replaced outright purchases and sales of government securities (which were dominant in the early 1990s) and central bank bills (CBB). There are several other instruments the PBC uses to manage liquidity conditions in the interbank market. The PBC may issue CBB to commercial banks to adjust the excess reserves of commercial banks, typically at three- and six-month maturities (Amstad, Sun and Xiong 2020). Central Treasury cash deposits (TCDs) – the Treasury's demand deposit held with the PBC – are also used. The PBC can deposit TCDs with commercial banks through an auction process, thus releasing base money during the period of the deposit.

[2] In the 2019 lending rate reforms, the PBC announced that the LPR would become the new reference rate for lending in China and that it would adjust how the rate was calculated. Under the existing arrangement, a panel of 18 banks submit the quotes they offer to their most creditworthy customers, expressed as a spread to the PBC's one-year MLF rate. The China Foreign Exchange Trade System, which publishes the LPR, closely monitors LPR quotation. The reforms also increased the importance of the MLF rate since the reforms made the LPR the new reference rate for lending in China and specified that LPRs would be quoted as a spread to the MLF rate (Das and Song 2022; RBA 2019). See RBA (2019) for further details.

[3] Prior to 2019, the LPR was expressed as a multiple of the equivalent-term official benchmark lending rate and was not generally used as a reference rate for pricing the loans of less creditworthy customers. The reforms improved the transmission of monetary policy by ensuring changes to the PBC's medium-term policy rate flow through more directly to lending rates. However, mortgage loans are only able to be repriced on a minimum cycle of one year, slowing the transmission of any potential monetary easing to the housing market (RBA 2019).

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Urban Residential Construction and Steel Demand in China

Adam Baird[*]

Photo: zhihao – Getty Images

Abstract

Investment in Chinese urban residential real estate has been declining since 2021, and demand for steel by the sector has also slowed considerably. Despite this decline, overall demand for steel in China has been resilient due to strong growth in manufacturing and infrastructure investment, which looks likely to continue in the near term. This article provides a projection for urban residential construction in China to 2050, suggesting that construction in China has peaked and that demand for steel will decline in the longer term. This will weigh on overall steel demand in China, though there remains considerable uncertainty around the longer term outlook for demand from other sources.

Introduction

Urban residential construction has been a major contributor to Chinese economic growth since the 1990s, but has declined in recent years due to a number of factors.[1] The sector has also been one of the largest sources of steel demand in China until recently. The decline in construction and in steel demand by the sector could weigh on overall investment growth in China in the long term and could also have significant implications for countries like Australia that export iron ore to China.

This article briefly discusses the recent downturn in Chinese urban residential construction and the near-term implications of this downturn for steel demand. The article then examines the long-term outlook for urban residential construction and steel demand in China, using new data and assumptions, and a new approach to estimating demolitions, to

provide a projection for urban residential construction to 2050.

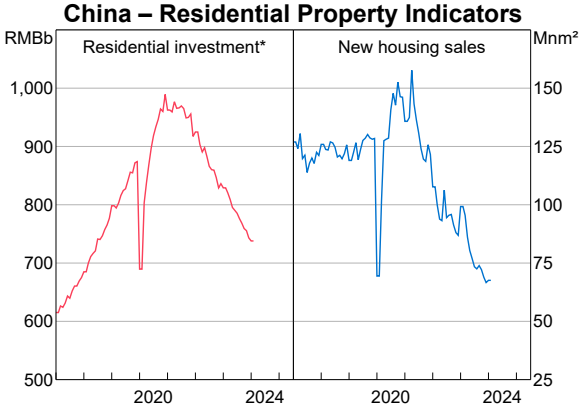
Recent developments in China's urban residential construction sector

Conditions in China's urban residential construction sector began to deteriorate in 2021, and they remain weak. This weakness, which followed a period of very rapid growth, reflects a combination of supply and demand side factors. On the supply side, authorities introduced the 'three red lines' policy in late 2020, which aimed to address financial stability risks by making it more difficult for highly leveraged developers to access credit (Hendy 2022). Authorities also introduced new demand-side tightening measures in many cities where housing prices had accelerated after the easing of China's initial COVID-19 restrictions in 2020. These measures, which included time limit restrictions on the resale of new housing and eligibility requirements for housing ownership, contributed to slowing demand for new housing. Declining revenue from new (typically in advance) housing sales and tighter access to credit, in turn, forced some developers to suspend work on their existing projects, resulting in the value of developers' residential investment in the economy decreasing by the end of 2021.

Several factors have contributed to the persistence of the downturn in investment since 2021. The suspension of existing work by developers led to rising concerns among households that homes they had purchased prior to construction would not be delivered. This concern, combined with slowing income growth and rising uncertainty around the economic outlook, has weighed on housing demand. Without income from new sales, funding challenges for developers have continued to worsen. At the end of 2023, developers' residential investment in China was around 20 per cent below its 2019 average level, and national new housing sales were almost 50 per cent lower (Graph 1).

Graph 1

China – Residential Property Indicators



* Nominal developer fixed asset investment.

Sources: CEIC Data; RBA.

Although authorities have provided material policy support for the residential construction sector since late 2021, there are few signs yet of recovery in the sector. Since 2021, authorities have guided mortgage costs for households lower, extended eligibility for home ownership in large cities, and largely removed limits on how many homes households can own. They have also repeatedly guided banks to expand their lending to developers, particularly to support the completion of unfinished housing. Despite this easing in conditions, new housing sales have declined, and most private developers continue to face considerable funding challenges. These ongoing challenges continue to pose a risk to financial stability in China (RBA 2023).

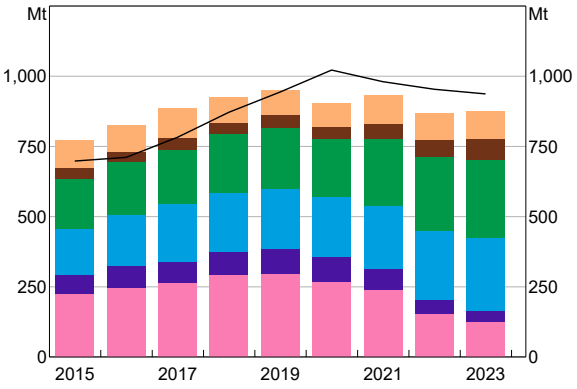
Urban residential construction's contribution to overall steel demand in China

The downturn in urban residential construction has reduced the sector's demand for steel. Urban residential construction consumed an estimated 296 million tonnes of steel at its peak in 2019 – 31 per cent of all steel used domestically in China (Graph 2; see Box A for details on the steel demand estimates). In 2023, the sector is estimated to have used less than half of that amount. Despite this, overall demand for steel in China has remained resilient, due mainly to strong growth in both infrastructure and manufacturing investment.

Graph 2

China – Steel Demand

With estimated contributions*



* Contributions are estimated from measures of sector output and assumptions about the steel intensity of production.

** Total is estimated from steel production less net exports and less the change in inventories.

*** Other includes the production of cars, ships, whitegoods, rolling stock and shipping containers.

Sources: CEIC Data; RBA.

In the near term, it is likely that infrastructure and manufacturing investment will continue to grow, with the support of fiscal and preferential lending policy measures. But in the longer term, headwinds to investment growth in these sectors from high levels of government debt, a declining population and a slowing rate of industrialisation mean that demand for steel from these sectors may grow more slowly or even decline. As a result, the longer term outlook for urban residential construction in China remains important to the outlook for Chinese steel demand and, in turn, Australian exports of iron ore to China.[2]

Projecting urban residential construction to 2050

To assess the longer term outlook for urban residential construction, and therefore its longer term contribution to steel demand, I project underlying demand for urban residential construction to 2050 following the approach of Berkelmans and Wang (2012). The projection is produced using new data and assumptions, as well as a new approach to estimating demolitions.

The projection is produced in two steps:

1. I estimate the future size of the urban housing stock in each year using projections of total population, the share of the population living in urban areas, and urban housing floor area per capita. In equation form:

$$\textit{urban housing stock}_t = \textit{total population}_t \times \textit{urban population share}_t \times \textit{urban housing floor area per capita}_t$$

2. I estimate demand for new construction in any given year as the difference between the housing stock in consecutive periods plus an estimate of housing that will be demolished. In equation form:

$$\textit{urban residential construction}_t = \textit{urban housing stock}_t - \textit{urban housing stock}_{t-1} + \textit{demolitions}_t$$

The assumptions for the key variables are:

- a decrease in total population to 1.3 billion people by 2050 and an increase in the urban share of the population to 80 per cent, consistent with United Nations (UN) projections
- an increase in urban housing floor area per capita to 43 square metres; by comparison, this is midway between the current levels in Japan and Germany
- a demolition rate of 1.5 per cent in 2015 falling to 0.5 per cent in 2050 based on demolition estimates from Chinese census data. These rates are considerably lower than those assumed in Berkelmans and Wang (2012).

Details on how these assumptions were determined are given in Appendix A.

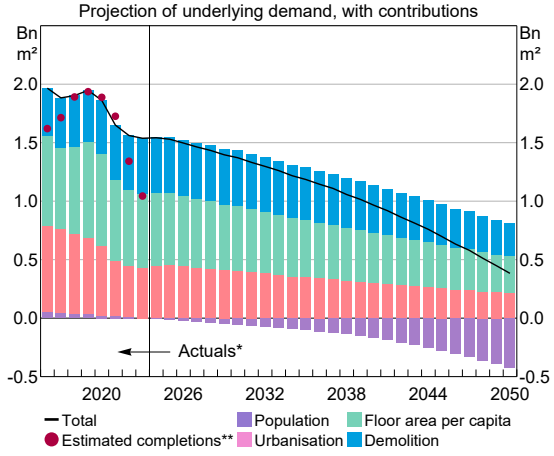
Projection results

Based on the projection results, urban residential construction in China has already peaked, and construction will decline over the medium-to-long term. These results are similar to those found by Berkelmans and Wang (2012), with higher assumed growth in floor area per capita offsetting a lower assumed demolition rate (Graph 3).

Graph 3

China – Urban Residential Construction

Projection of underlying demand, with contributions



* Actuals are used up to 2023 for the urban share, and up to 2020 for population and floor area per capita. Projections are used thereafter. Demolitions are projected for all years.

** Weighted average of new commodity housing starts for the current and previous three years plus estimated social housing completions.

Sources: CEIC Data; NBS; RBA; United Nations Population Division.

That said, the projection implies that construction should eventually recover from its current low levels, as estimated completions have significantly undershot estimates of underlying housing demand.[3] However, the timing of this recovery will depend on how quickly developers can resolve their debt and funding challenges, and when demand for housing recovers.

Scenario analysis

I test the sensitivity of the projection to two assumptions. The downside scenario assumes a portion of the existing vacant stock of housing becomes occupied, thus reducing the need for new construction even further. And the upside scenario assumes a higher average demolition rate, given the uncertainty around estimating this variable.

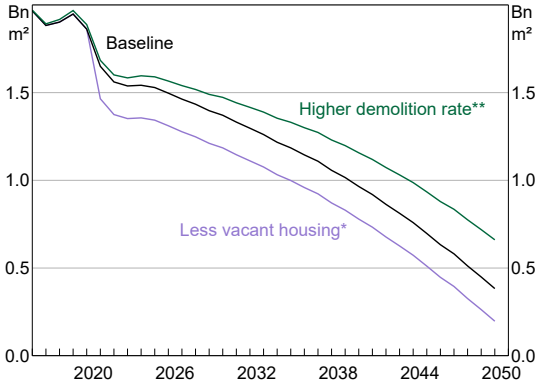
The main downside risk to the baseline projection, which assumes that the stock of vacant housing is unchanged, comes from the possibility of a large reduction in vacant housing. Developers in China hold large stocks of finished-but-unsold housing, and many households own unoccupied housing (Glaeser *et al* 2017). Since the baseline projection relies on estimates of occupied rather than total housing, a drawdown of developer inventory, or sales of unoccupied housing to owner-occupiers, would imply less construction than in the baseline projection for an equivalent level of demand.[4]

Based on estimates of the owned-but-unoccupied stock and developer inventory, the vacancy rate for 2022 was around one-quarter of the total housing stock.[5] Assuming that the vacancy rate instead declines to 10 per cent of the housing stock by 2050 – which is comparable with current vacancy rates for many advanced countries – results in a material reduction in the projected volume of new construction by 2050 ('less vacant housing' line in Graph 4). This is because a larger share of future demand for housing would be met by existing stock in such a scenario.[6]

Graph 4

China – Urban Residential Construction

Projection scenarios



* Combined developer and owned-but-unoccupied stock assumed to fall gradually from 26 to 10 per cent of total stock.

** Demolition rate assumed to fall from 1.5 to only 1 per cent over the horizon.

Sources: CEIC Data; NBS; RBA; United Nations Population Division.

I also test the sensitivity of the projection to the assumed demolition rate, as this is the least certain of the assumptions. In this upside scenario, the demolition rate is assumed to fall from 1.5 per cent to only 1 per cent by 2050. Relative to the baseline, there is little difference in the near term. But by the end of the horizon there is a more pronounced difference, with projected construction significantly higher at almost 700 million square meters in 2050 ('higher demolition rate' line in Graph 4).

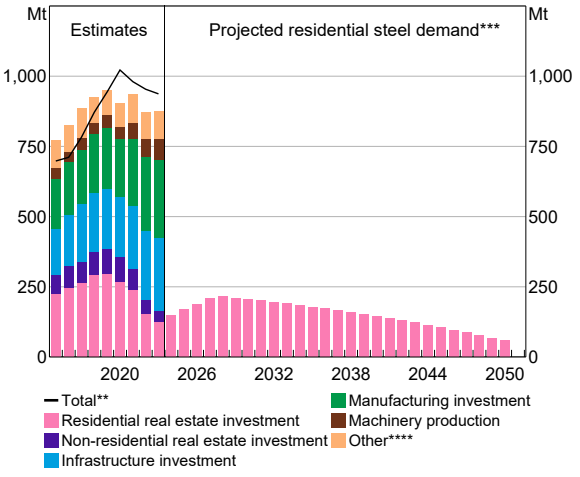
Implications for steel demand in China

Liaison conducted by the RBA's Beijing Office suggests that urban residential property construction in China uses an average of 1.5 tonnes of steel per 10 square metres built. The baseline scenario therefore implies that annual steel demand from residential construction in China will decline to 58 million tons in 2050 (though this figure could be as low as 30 million tons under the lower vacancy rate scenario or as high as 99 million tons assuming a higher demolition rate) compared with 296 million tons in 2019 (Graph 5).

Graph 5

China – Steel Demand

With estimated contributions*



* Contributions are estimated from measures of sector output and assumptions about the steel intensity of production.

** Total is estimated from steel production less net exports and less the change in inventories.

*** Assuming construction levels converge to the baseline projection over five years from 2024.

**** Other includes the production of cars, ships, whitegoods, rolling stock and shipping containers.

Sources: CEIC Data; RBA.

The weak long-term outlook for steel demand from urban residential construction is consistent with the RBA's previous assessment that growth in overall Chinese steel demand is likely to slow in the future and may be near its peak (RBA 2017). This outlook factors in slowing steel demand from residential construction, as well as headwinds to the longer term outlook for manufacturing and infrastructure investment, which are other important sources of steel demand. Slowing overall steel demand in China could weigh on global demand for iron ore and, all else equal, its price.

Conclusion

Weakness in the Chinese urban residential construction sector has persisted since 2021, and has significantly reduced the sector's demand for steel. However, overall demand for steel has remained resilient due to recent growth in infrastructure and manufacturing investment. Investment growth in these sectors looks set to continue in the near term, but there is considerable uncertainty around the long-term outlook for such investment. This uncertainty means the outlook for urban residential investment remains a key risk to the outlook for Chinese steel demand.

Projections to 2050 indicate that demand for urban residential construction in China has likely peaked. While some recovery in construction activity is likely in the near term (as current levels of construction have fallen below those estimates of demand), urban residential construction will likely continue to weigh on overall demand for steel in China.

Box A: Chinese steel demand estimates

By Tekla Bastian*

The steel demand estimates shown in Graph 2 are based on estimates of output and assumptions about how steel-intensive production is for a range of sectors in China. The estimates of steel demand currently incorporate data and assumptions for 13 infrastructure sectors, manufacturing investment, residential and non-residential real estate investment, and the production of 34 industrial outputs including ships, cars, whitegoods, rolling stock and heavy machinery.

The assumptions of steel intensity used to produce the estimates depend on how outputs are measured:

- For sectors where the outputs are measured as *volumes produced* (e.g. the number of cars), the average weight of the product and the steel share by weight are assumed. Together, these give an estimate of how much steel is used per unit produced, and when multiplied by the number of units produced, this gives an estimate of the steel required to produce that output. These assumptions are more exact for some products than others (mainly depending on how uniform the produced outputs are).
- For sectors where *expenditure* is measured, assumptions are made about the share of steel in that spending. For example, 20 tonnes of steel is assumed to be used for every million yuan of spending on highway investment. This corresponds to around 8 per cent of spending. These assumptions are based on estimates from industry liaison, but are likely to be less precise than assumptions for production-based estimates of steel demand given how broad the categories of expenditure are.
- For real estate investment, 0.15 tonnes of steel is assumed to be used for every 1,000 square metres of construction. This is also based on industry estimates.

Since 2015, these estimates of steel demand have been comparable to an alternative estimate of Chinese steel demand ('total' line in Graph 2), which is calculated by subtracting net exports and the change in steel inventories from Chinese steel production. Remaining data gaps include the defence sector and machinery production where data are limited, and imperfect assumptions about steel intensity are a likely source of error in both directions.

**Tekla Bastian undertook the work behind the steel demand model used in these estimates while in Economic Analysis Department. If referencing this steel demand model, please use the following attribution:*
Bastian T (2024), 'Box A: Chinese Steel Demand Estimates', RBA Bulletin, April.

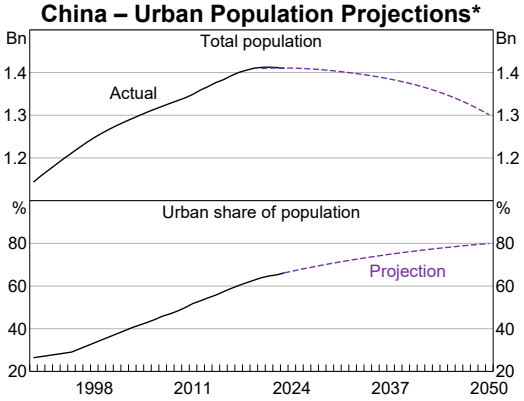
Appendix A: Urban residential construction projection assumptions

Urban population

The projection for China's population is based on the UN's medium scenario projection from its World Population Prospects (2022), while the projection for the urban share of the population is based on the projection from the UN's World Urbanization Prospects (UN 2018; UN 2022) (Graph A1). Both measures have been adjusted slightly to align with official population estimates from China's National Bureau of Statistics (NBS) up to 2023, which have been slightly lower than the UN's projections in recent years.

Graph A1

China – Urban Population Projections*



* UN projections adjusted to align with NBS estimates of total population and the urban share up to 2023.

Sources: CEIC Data; RBA; United Nations Population Division.

A material share of measured urbanisation in China in recent years has come from reclassifying communities on the periphery of major cities as urban rather than rural. This means residents of these communities are already housed when they are reclassified as urban residents. However, since most of these households live in low quality rural housing, they will still contribute to demand for new improved housing (Gan *et al* 2019).

Housing floor area per capita

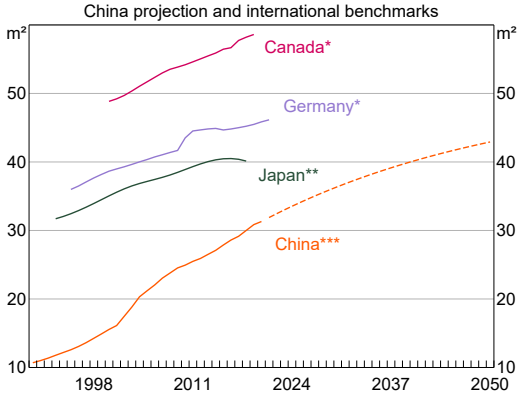
Housing floor area per capita is an indicator of housing consumption, and it typically increases with household income (Berkelmans and Wang 2012). Floor area per capita could increase as a result of households either growing smaller and/or living in larger homes.

I project floor area per capita by comparing current estimates for China against those for a selection of other countries at a more advanced stage of development. By applying judgement and taking into account differences across measures for different countries, I assume that urban floor area per capita for China in 2050 will reach 43 square metres per person.[7] This is between the current levels in Japan (where housing is small due to severe geographical constraints) and Germany (where housing is larger due to a more dispersed population, but not as large as in Canada where most households live in detached houses) (Graph A2).

Graph A2

Housing Floor Area per Capita

China projection and international benchmarks



* Total area of housing stock divided by population.

** Average dwelling size divided by average household size.

*** Usable floor area assumed as 80 per cent of gross (including shared space) for comparability. Dashed line is projection.

Sources: CEIC Data; RBA; Statistics Bureau of Japan; Statistisches Bundesamt.

The Chinese data on floor area per capita measure only lived-in housing. As a result, the projections are sensitive to the quantity of vacant housing in China, and how much of it is sold to satisfy demand in the future. The baseline projection for residential construction demand assumes the stock of vacant housing does not change over the forecast period. But I also consider a scenario where the estimated share of vacant housing declines over time to levels that are similar to advanced economies today.

Demolitions

Some percentage of the housing stock is demolished every year, which will add to the construction that would otherwise be required to meet overall housing demand. Previous attempts to estimate demolitions have produced a wide range of results. For example, Berkelmans and Wang (2012) assumed a demolition rate

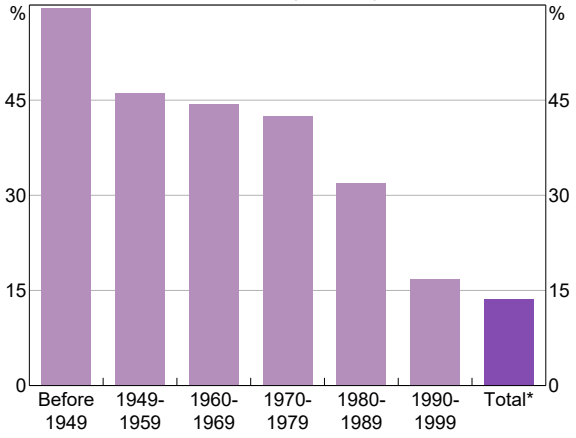
that fell from 4.5 per cent in 2010 to 2 per cent by 2030, while Rogoff and Yang (2022) assumed a rate averaging 1.4 per cent.[8]

The work presented in this article uses a novel approach: inferring demolition from changes in the age distribution of the housing stock from census data. More specifically, I start by observing the stock of occupied housing that was constructed in different year ranges in both 2010 and 2020. For all year ranges prior to 2000, I assume that any declines in the occupier housing stock over that period measure the number of dwellings demolished. Older housing in China tends to be lower quality and have a relatively short lifespan, so I assume that most are demolished rather than simply vacated and, for example, held as an investment. This assumption is consistent with estimates of building lifespan in China that are as low as 25 years (Wang, Zhang and Wang 2018). This approach suggests around 14 per cent of 2010's occupied urban housing stock was demolished by 2020 (Graph A3). In annual terms, this averages around 1.5 per cent each year.

Graph A3

China – Housing Demolitions

Share of 2010 stock demolished by 2020, by period of construction



* Estimated by dividing all demolished dwellings by the total stock in 2010 (including housing built after 1999).

Sources: NBS; RBA.

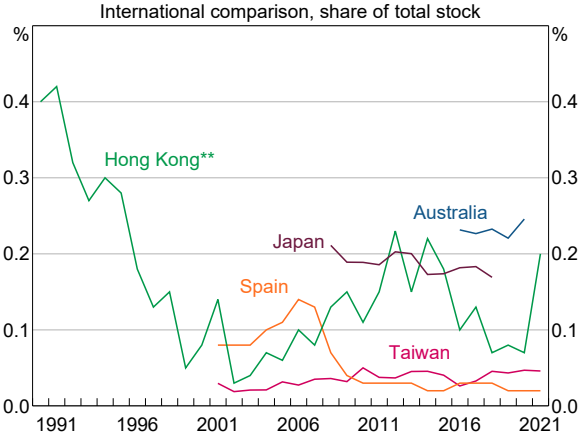
The estimates are lower than those used in previous work, but closer to the rates observed in other countries (Graph A4). Indeed, demolition rates in advanced economies are even lower than the estimate for China, though this is to be expected given the higher average quality of housing in advanced economies.

I assume the demolition rate falls from 1.5 per cent in 2015 to 0.5 per cent by 2050 as the share of new higher quality housing increases. This is roughly equivalent to the demolition rate for Hong Kong in 1990. I also consider an upside scenario where the assumed demolition rate falls to only 1 per cent by 2050.

Graph A4

Housing Demolition Rates*

International comparison, share of total stock



* Number of dwelling demolitions or approved demolitions divided by estimated stock.

** Estimates for market sector housing only.

Sources: Australian Bureau of Statistics; CEIC Data; RBA; Statistics Bureau of Japan.

Endnotes

[*] The author is from Economic Analysis Department. He would like to acknowledge Tekla Bastian's role developing the steel demand model used for this work, including the methodology given in Box A.

[1] I estimate the direct contribution of residential investment to GDP at 11.3 per cent in 2022, down from a peak of 17.2 per cent in 2013. Kemp, Suthakar and Williams (2020) estimated the combined direct and indirect contribution at 18 per cent in 2020, down from a peak of 20 per cent in 2016.

[2] The volume of Australian iron ore exports and the price received for these exports will depend on how global steel and iron ore demand evolves, including in countries outside China. In 2022, China's share of world steel demand was 51 per cent and its share of world iron ore imports was 66 per cent.

[3] I estimate urban housing completions as a weighted average of current and lagged new commodity housing starts plus an estimate of social housing completions from official sources.

[4] This process is partly underway; developers' inventory of unsold housing has declined since 2020. While existing home sales by households have been resilient relative to new housing sales, they have not yet grown by much since 2021.

[5] The occupied stock of housing is estimated from data in the 2020 Chinese census. Adding to this the stock of housing that is owned, but unoccupied by households (based on the China Household Finance Survey in 2019) gives the household-owned stock of housing. Developers' unsold inventory is estimated as the cumulative difference between new housing starts and sales since 1995. Adding this to the household-owned stock gives an estimate of the total housing stock. Subtracting the occupied stock from this gives an estimate of the total vacant stock.

[6] Assuming Chinese floor area per capita rises only to Japan's current levels by 2050 reduces projected new housing and steel demand by a similar magnitude to the scenario where the vacancy rate falls to 10 per cent.

[7] Official measures for China include shared space in apartment buildings (Rogoff and Yang 2022). These are multiplied by 0.8 to produce comparable estimates with other countries, where this space is not included. Estimates from some other countries also capture vacant housing. This is not adjusted for, but was considered when, comparing the estimates.

[8] The demolition rate estimate used by Berkelmans and Wang (2012) was based on government reports and depreciation estimates from the national accounts. The rate used by Rogoff and Yang (2022) applies assumed building lifespans to a distribution of housing by period of construction.

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